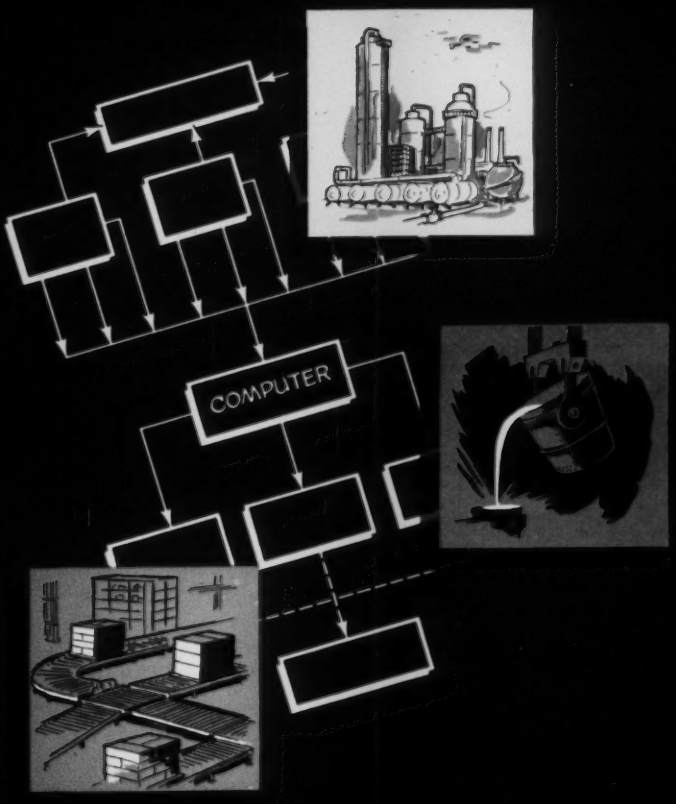
AUTOMATION



Role of Computers

IN AUTOMATION

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

Vaughn Haynes, right, manager of production engineering, discusses "trap" line scheduling with Wilfred Pascoe, superintendent of press room.

Chrysler blanks strip steel by "trap" shearing on Wean coil processing line

Trapezoidal shearing from coil is, in many cases, the most economical way to prepare blanks for subsequent press operations. Two, independent, pivoting shear heads allow selection of the most economical proportions of the blanks for the finished shapes. This "tailoring" of the material to the end parts eliminates much of the material loss that would result if these same parts were stamped and drawn from square-cut sheets.

Wean has designed and built almost all of the "trap" shear lines used today. The installation shown is at Chrysler Corporation's mammoth Twinsburg, Ohio stamping plant. This Wean coil processing line incorporates strip cleaning, flexing, leveling and shearing operations that turn as-received mill coil into sheet, ready for press work.

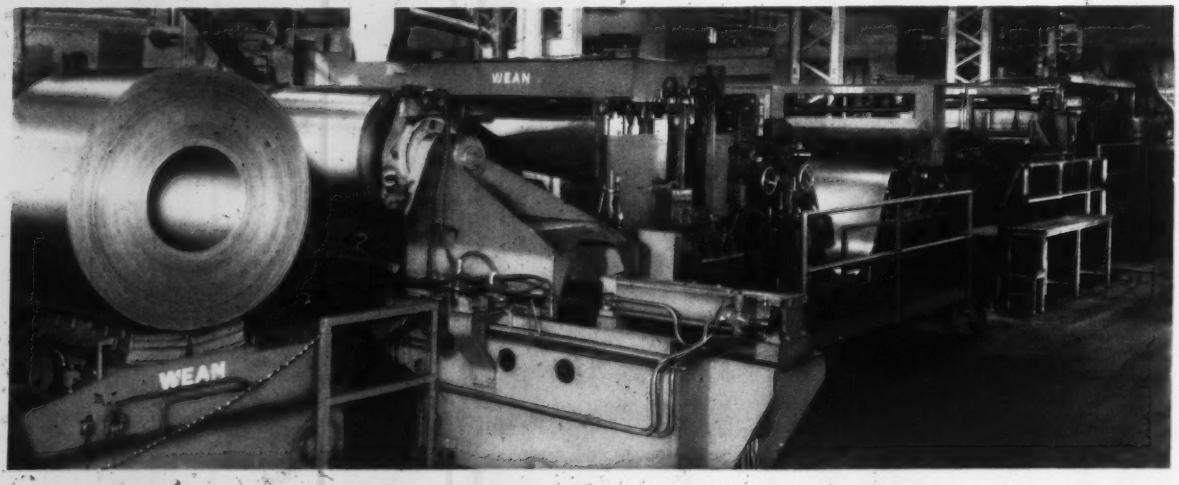
Today, more and more alert metalworking firms are turning to coil processing as one of the answers to rising production costs. If your firm uses approximately 500 tons/month of flat-rolled steel, you may be missing major material and overhead savings if you still purchase in sheet form.

An experienced Wean sales engineer will be able to tell you, or your production executives, if coil processing can cut your costs—and how much. Many firms have amortized the equipment costs involved within one year.

WEAN EQUIPMENT CORPORATION
CLEVELAND 17, OHIO
Detroit · Chicago · Newark

WEAN

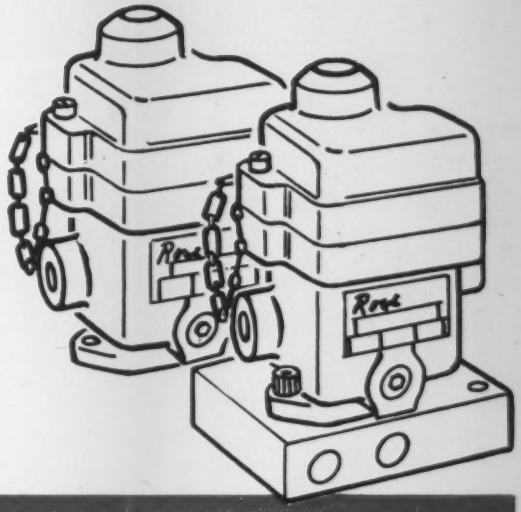
Wean trapezoidal shearing line at Chrysler's Twinsburg Stamping Division plant produces blanks for body stampings from coils weighing up to 30,000 pounds.



Circle 651 on Page 19

The Ross PACER gives you 56 new solenoid air valves

The Ross PACER is a fine new solenoid valve in the ⅛" and ¼" size range that gives a full ⅜" flow capacity yet uses only 7 watts of holding power. The PACER is built for especially long life yet is priced surprisingly low. Capable of 1000 cycles per minute and more, is JIC, and very light and compact. And if you're interested in large valves the PACER has a second identity, that of a pilot section to actuate *any* valve of the Ross Skyline series. It will operate any of these valves at top speed and with low power consumption.

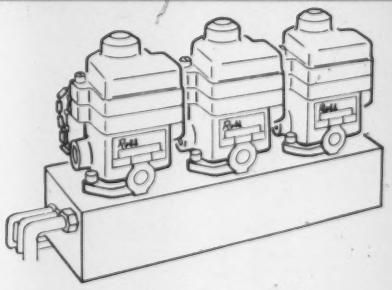


As well as being a complete new valve

...PACER is also a new pilot section in the Ross Skyline valve series...

COMPLETE PACER VALVES	PIPE SIZES ⅛"	¼"	⅜"	½"	¾"	1"	1¼"
STRAIGHTWAY, N/C	√	√					
3-WAY, N/C	√	√					
4-WAY	√	√					
SKYLINE VALVES USING PACER AS ACTUATOR (HEAD)							
STRAIGHTWAY, N/C		√	√	√	√	√	√
STRAIGHTWAY, N/O		√	√	√	√	√	√
3-WAY, N/C INLINE MT.		√	√	√	√	√	√
3-WAY N/O, INLINE MT.		√	√	√	√	√	√
3-WAY, N/C, BASE MT.		√	√	√	√	√	√
3-WAY, N/O, BASE MT.		√	√	√	√	√	√
4-WAY, INLINE MT.		√	√	√	√		
4-WAY, BASE MT.		√	√	√	√	√	√
4-WAY, 5-PORT		√	√	√	√		

New **PACER** manifolds to save piping and wiring



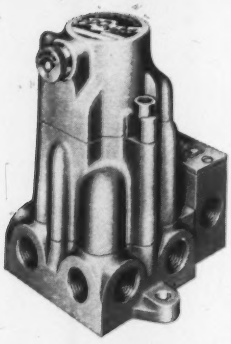
Ross manifolds provide a compact and economical method of multiple mounting PACER valves. One air supply line and one electrical conduit can serve all PACER valves. Manifolds are available in two and three stations.

STAY AHEAD MODERNIZE

Ross OPERATING VALVE COMPANY
131 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

Circle 654 on Page 19

Compare what the **PDQ WILL DO...**
Compare the **PDQ PRICE...**
With any other air valve...



a ½" valve that will do a ¾" valve job at a ⅜" valve price

- ☑ Accessibility
- ☑ Simplicity
- ☑ Speed and Capacity
- ☑ Price and Quality

What will the PDQ do? It will do a ¾" valve job. It has faster response time and greater capacity than valves twice its size and four times its weight. To repack you simply replace 2 self-contained units in less than a minute. You can change valves on the line in less than 30 seconds.

Will the PDQ last? The PDQ has a short stroke, and a light but rugged aluminum construction with built-in wear compensation. Anticipated valve life is conservatively estimated at 35 million cycles . . . on most applications this is **years** of trouble-free service. Coil (properly applied) is unconditionally guaranteed for the life of the valve.

How about the price? The PDQ is a ½" valve at a ⅜" valve price. Write us today.

A. V. Ney

A. V. Ney, Sales Manager

HUNT VALVE COMPANY · SALEM, OHIO, U. S. A.

HUNT H V C **Quick-As-Wink** AIR & HYDRAULIC CONTROL VALVES

MARCH 1960
Vol. 7—No. 3

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Manufacturing Operations

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automation outlook

EFFECTIVE DATA TOOLS SURE OF USE

". . . A study of the technology of the last 10 years leaves little reason to doubt that the 1960's will see computers achieve a notable place in our society. With modern man's propensity to apply tools whenever progress can be served, the role of a tool is assured when that tool aids in the solution of so universal a problem as obtaining effective data handling. . . ."—*John H. McRainey, associate editor, see page* 48.

PRODUCT COMPLEXITY UP—MANHOURS CONSTANT

". . . Contrary to what seems to be popular impression, the number of manhours that go into building a General Motors automobile, aside from any accessories and optional equipment, has remained substantially unchanged over the postwar period, despite improvements in manufacturing methods and increased mechanization. . . . This is not to say that manhours on all operations are the same now as they were ten years ago. The fact is that the increased complexity of cars and trucks today has just about offset gains from improved methods and processes. . . ."—*L. G. Seaton, vice president-personnel, General Motors Corp.*

ELECTRONIC GEAR REQUIRES PRODUCTION SHORTCUTS

". . . The vast amount of electronic equipment that will be required for the future can no longer be hampered by handling and expensive concern for each individual component, in other words the "Electronic bolts, nuts, and screws." The multibillions of twisted and soldered joints with attendant human error must be replaced by mass methods. There would not be enough men, women, and children on the North American Continent to build and solder, by the old methods, all the electronic gear required. . . ."—*W. S. Parsons, president, Centralab, Division of Globe-Union Inc.*

AUTOMATION IN GLASS

". . . I predict that automation, already well advanced, will become an increasingly potent force, and that by 1970 the output per employee will be doubled. [Reference is to glass container industry.] Our applied color labeling, selecting, packing, and warehouse operation offer great potentials for further automation, and these alone employ nearly 80 per cent of the present factory work force. . ."—*Dr. A. L. Wishart, president, Knox Glass Inc.*

ONE-MAN CONTROL OF 1700-MILE PIPELINE

". . . Control of the entire pipeline, including the automatic operation of the five centrifugal stations and the automatic control of two transport measuring stations, has been successfully achieved from a central dispatching headquarters at Nashville, Tenn. . . . Presently work is going forward on completely automating the initial five semiautomatic reciprocating stations. This work should be completed by summer. . . . The entire Columbia Gulf system will be controlled automatically from Nashville under the direction of one man per shift. The present system . . . consists of 1700 miles of pipeline and 11 compressor stations totaling 155,850 hp. . . ."—*Sy Orlofsky, vice president, Columbia Gulf Transmission Co.*

AUTOMATION

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BPA NBP

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. . . Fluid Power news

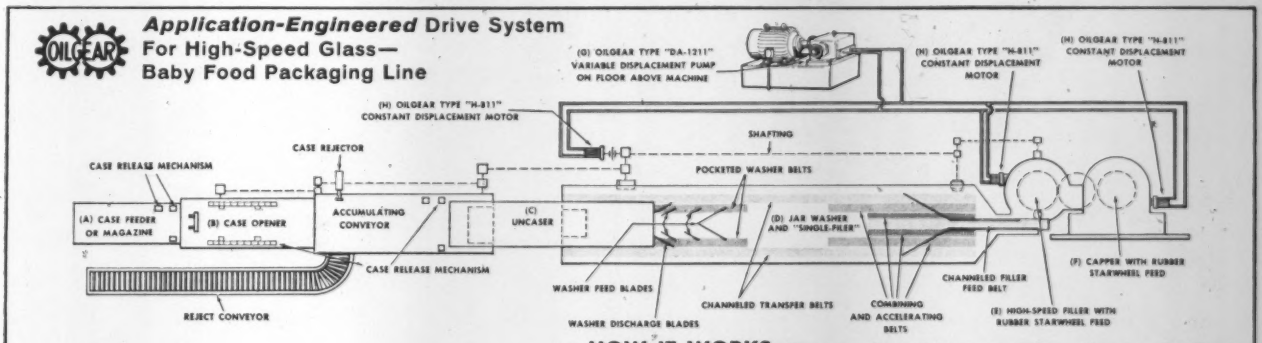
REPORT NO. 11,303 SPEED—COST "BREAK-THRU" FOR GLASS PACKAGING

From Oilgear Application-Engineering Files

HOW OILGEAR SYSTEMS *on Gerber's Integrated Glass Lines* BOOST OUTPUT—CUT COSTS

USER: *Gerber Products Company, Fremont, Michigan; Rochester, New York; Oakland, California*

DATA: To sharply reduce breakage, jam-ups, downtime, and labor costs in filling glass baby food jars at higher speeds, Gerber's Engineering Research Department developed the first fully integrated, high-speed machine for packaging foods in glass economically, under completely automatic control. *Drive Requirements for this multi-unit machine were outlined as follows:* 1. Complete synchronization of the seven integrated units through three drives—at the Uncaser, Filler, Capper. 2. Positive, precise, remote pneumatic control of operating speed that is instantly, infinitely variable from very slow to top speed while the machine is running. 3. Controlled acceleration and deceleration to prevent jars from tipping and jamming, eliminates spillage, reduces machine strain. 4. Compact, for maximum work area. 5. Independent operation of Filler and Capper drives to facilitate cleaning. 6. Trouble-free, dependable, long-life operation, immune to frequent sanitary washdowns, fully enclosed to prevent food contamination.


OILGEAR
Application-Engineered Drive System
For High-Speed Glass—
Baby Food Packaging Line
(G) OILGEAR TYPE "DA-1211" VARIABLE DISPLACEMENT PUMP ON FLOOR ABOVE MACHINE
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
(H) OILGEAR TYPE "H-811" CONSTANT DISPLACEMENT MOTOR
SHAFTING
CASE REJECTOR
CASE RELEASE MECHANISM
POCKETED WASHER BELTS
(A) CASE FEEDER OR MAGAZINE
(B) CASE OPENER
ACCUMULATING CONVEYOR
(C) UNCASER
(D) JAR WASHER AND "SINGLE-FILER"
(F) CAPPER WITH RUBBER STARWHEEL FEED
CASE RELEASE MECHANISM
WASHER FEED BLADES
CHANNELED FILLER FEED BELT
CHANNELED TRANSFER BELTS
COMBINING AND ACCELERATING BELTS
(E) HIGH-SPEED FILLER WITH RUBBER STARWHEEL FEED
WASHER DISCHARGE BLADES
REJECT CONVEYOR

HOW IT WORKS. One man feeds 24-jar cases—flap side up—onto Case Feeder (A). Timing mechanism synchronizes delivery to Case Opener (B) where carton flaps are lifted out. Unopened flaps or inverted jars cause automatic case rejection. Normal cases proceed to Uncaser (C) where the case and divider panels are pushed down and away from the jars. Uncaser deposits jars on transverse-channeled conveyor platens. Blades slide jars from channeled platens into pocketed belts which hold jars inverted through Washer (D). Jars are plowed from washer belt pockets to transverse-channeled combining and accelerating belts—moving 350 to 400 jars per minute . . . are then "shuffled" into the "Single-Filer"—550 to 650 jars per minute on a channeled belt to Filler (E). Rubber starwheels minimize breakage in feeding the 25-pocket Girdler Filler (E), and 16 twin-head Anchor-Hocking rotary Capper (F) . . . both custom-built for Gerber with center-to-center jar spacing for positive, smooth glass transfer between units. Smooth synchronization, cushioned acceleration and deceleration provided by the Oilgear Drive and Control System, combined with no jar-to-jar contact make possible the almost noiseless higher speeds and virtual elimination of glass damage . . . for if even a single jar or bottle is broken in food or pharmaceutical operations, a complete and costly shutdown, cleanup and inspection of the packaging line by quality control personnel is required.

SOLUTION: An Oilgear "*Any-Speed*" Drive, consisting of a Type "DA-1211" variable displacement pump and three Type "H-811" constant displacement motors—powers all elements of "The Gerber Integrated Glass Lines" to *meet and exceed originally specified drive requirements.* For maximum work area around the "Glass Line," prevention of possible food contamination, and use of an economical electric motor, the Oilgear "*Power-Pak*" is located on a different floor of the building. A compact control panel located at the Filler enables the operator to start, stop, jog, and instantly vary speed of the entire machine through an infinite range while the machine is running—thereby obtaining maximum efficiency for the consistency of the food being filled. The drive system automatically synchronizes the speed of all seven machine units. Operating speed ranges from 550 to 650 jars per minute—depending entirely upon the products being filled . . . *an increase of up to 23% over former conventional glass packaging methods.*

GERBER REPORTS—"*The major advantages of this newly developed equipment are: less shock and scratching of jars, which reduces damage; substantially higher speeds: more thorough washing; lower maintenance cost and automatic control of all segments of the line.*"

Due to the smooth, cushioned application of power, even at higher speed, reduced glass damage and the resulting reduction in downtime, maintenance and labor costs with this Oilgear-powered, Gerber-designed machine, an expanded installation program of these "Integrated Glass Lines" is now under way at all Gerber plants.

"PLUS" features of this Oilgear Drive and Control System are: dual, automatic, built-in hydraulic and electric overload protection—stops the machine in event of jamming or malfunction . . . automatic hydro-dynamic braking . . . direct torque reading at the control panel . . . constant pressure and flood lubrication with continuous power fluid filtration . . . complete flexibility for location of drive and control components . . . fast, easy installation . . . standard drive and control components sealed against washdowns . . . lower power consumption—using only power in proportion to work performed. There are many more—but these alone should be sufficient proof why designers and builders of machinery are turning to Oilgear, and say . . .
"*for the lowest cost per year—it's OILGEAR!*"

For similar practical solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

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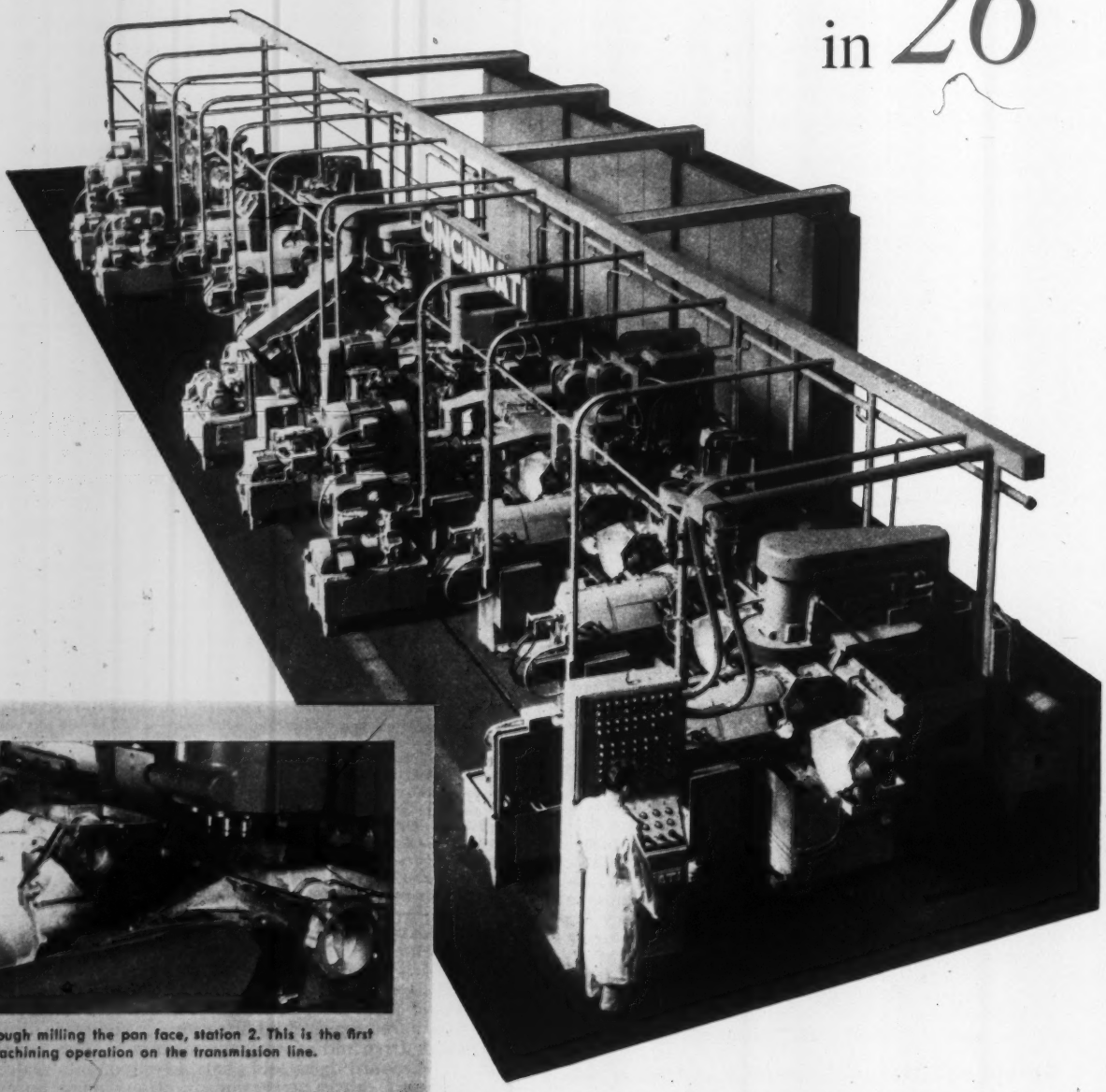
CINCINNATI | SPECIAL MACHINE DIVISION incorporates in 26



Rough milling the pan face, station 2. This is the first machining operation on the transmission line.

CINCINNATI 26-STATION TRANSFER LINE at Ford Motor Company's new plant in Sharonville, Ohio, automatically bores, mills and drills automatic transmission cases in 33 machining operations. Accuracy and finish are excellent. The machine cycles 137 times per hour.

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • VERTICAL AND HORIZONTAL BROACHING

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

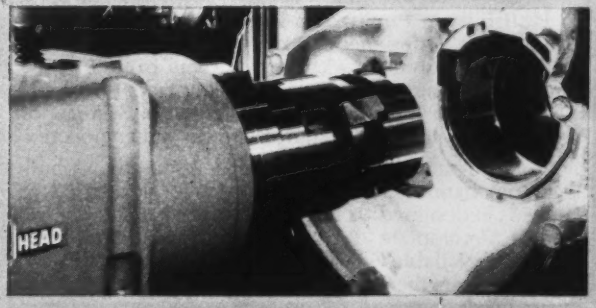
Dependable Productivity

-*station* TRANSFER LINE...

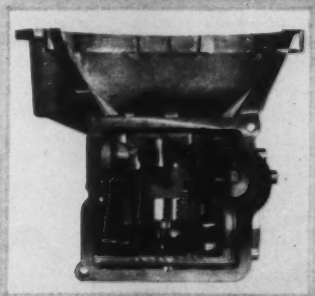
Aluminum transmission cases require gentle handling and firm, balanced clamping during the machining operations . . . and a high degree of dependability in the production equipment. All these requirements are incorporated in the CINCINNATI 26-Station Unit Type Transfer Machine illustrated at the left. This production line mills, drills and bores Ford automatic transmission cases; inserts two bushings; automatically banks excess parts; transfers the casting from one station to the next. There are 26 stations, allocated as follows: 10 for machining, one for inserting bushings, one for banking, one for future engineering changes, and the remainder for other functions required in a modern transfer line. Several outstanding advantages are incorporated in this line, including unit construction and complete static electrical control.

Cincinnati engineers and builds special machines and complete production lines varying in complexity from small bearing-shell broaching machines to giant production lines performing a multitude of operations. Make Cincinnati your first choice for equipment of this type. The Special Machine Division is ready to serve you.

CINCINNATI



Boring and chamfering the large diameter. At the same time, boring and facing operations are performed from the other end. Station 8.



Inside the transmission case. Hard-to-reach surfaces are easily machined on the CINCINNATI Transfer Line.

MACHINES • COMPLETELY AUTOMATED PRODUCTION LINES

CINCINNATI®
SPECIAL MACHINE DIVISION

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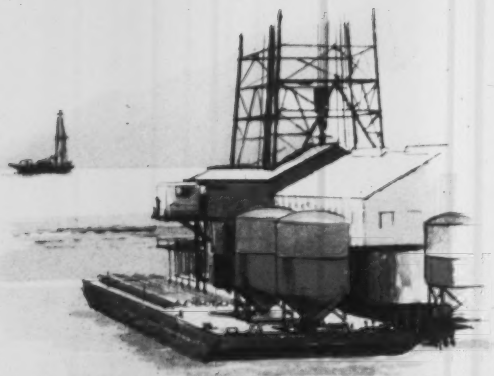
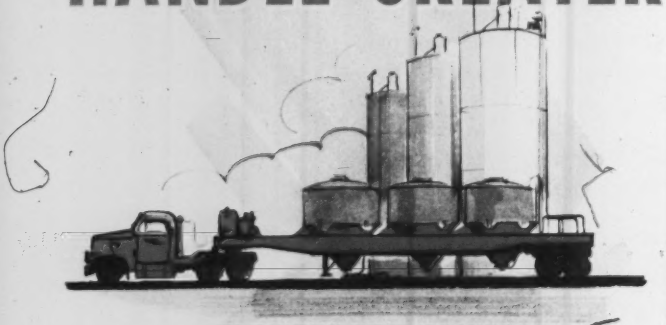
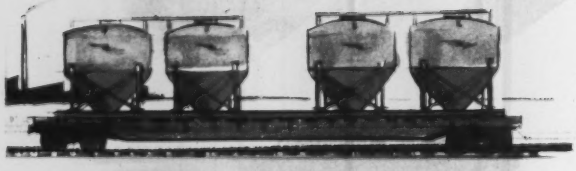
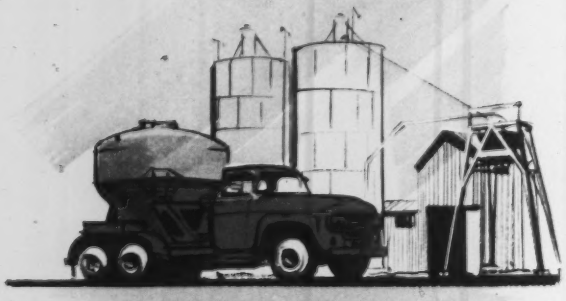


HANDLE GREATER BULK VOLUMES







Since 1940, Halliburton has led the way in the development of more efficient equipment specifically designed to handle all types of bulk materials.

The system originated as a result of Halliburton's world-wide services with bulk cement for oilfield use in onshore and offshore operations.

The experience, techniques and knowledge gained over the years has led to applications of these advanced pneumatic mobile and stationary systems capable of handling a wide variety of finely divided, free-flowing materials, bulk chemicals and other materials including those in pelletized form. Bulk materials are pneumatically discharged from the bulk handling equipment.

The overall productivity of Halliburton pneumatic bulk material handling systems are augmented by several unique devices also developed by Halliburton Research. Some of these include: *The Densometer* . . . which gives continuous and accurate measurements of fluid density. Storage bins with *Weighing Device* . . . for more accurate control of material mixing, *Weight Sensing Element* . . . to relay signal from each storage bin leg to a *Load Indicator* . . . which indicates the totalized weight of the materials directly on a dial.

Halliburton Pneumatic Bulk Material Handling Equipment is designed for materials ranging from 16 to 165 lbs. per cu. ft. – conveying them from 0 to 100 cu. ft. per minute at distances varying from 0 to 1,400 feet and with as much as a 100 foot rise. Systems of greater capacities and distances are custom engineered.

Take advantage of this most modern method of bulk material handling! Equipment may be purchased or leased . . . designed to help meet your specific requirements . . . complete engineering and installation services are available . . . or may be installed by the user. Write for further detailed information applicable to your needs.

HALLIBURTON

PNEUMATIC BULK MATERIALS HANDLING EQUIPMENT

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

Circle 658 on Page 19

AUTOMATION news

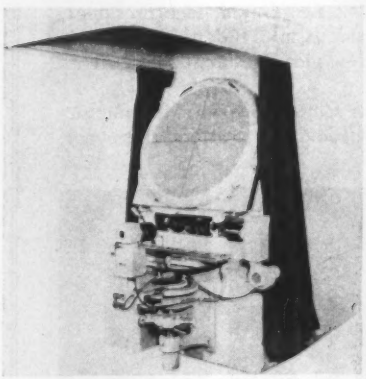
Today's events and developments in the field of automation

Machine Tool Builder Offers Equipment Lease Plan

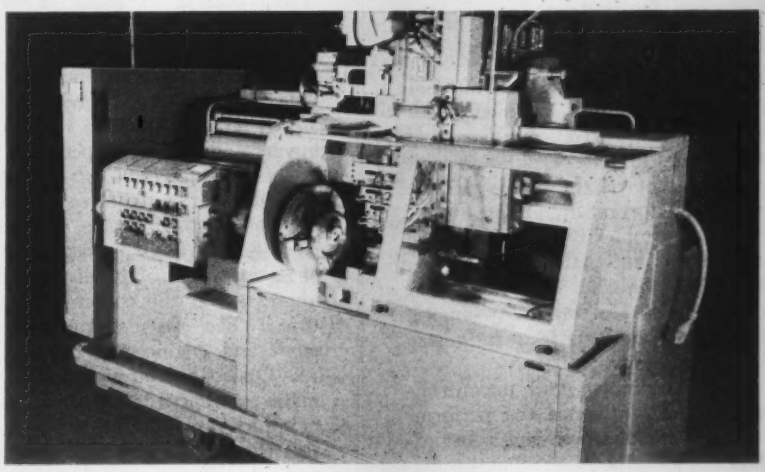
LEASE PLAN recently announced by Jones & Lamson Machine Co. is designed to enable manufacturers to acquire needed machine tools and other production equipment with no initial outlay of capital. Instead, lease payments, beginning 30 days after shipment, are made out of income derived from use of the equipment.

The new lease plan is a package deal, and may cover all of the equipment required to complete a given modernization or expansion program. Equipment may be leased complete with all necessary standard and special tooling. Perishable tools may also be included in the plan.

Under the leasing arrangement, a lessee commits himself to leasing one or more pieces of equipment for a specific period of time, usually five years, at a lease rate of $20.50 per $1000 value of equipment. The manufacturer's guarantee period applies to each piece of leased equipment. Lessee is responsible for maintenance and repair of the equipment, but has no obligation involving ownership risks other than that of securing insurance coverage.



OPTICAL comparator has a 30-inch screen and is suitable for inspection of part profiles, screw threads, assembly fits, etc. Unit may be leased for $246 per month.



TRACER lathe can be leased for $922.50 per month for five years and $307.50 per month thereafter. In one application, a manufacturer of tandem axles will use the machine instead of seven old multiple tool lathes to save $2400 per month on labor costs alone. In addition, maintenance and repair on the new machine will be less than for the old machines.

When the five-year lease period is completed, the lessee may turn back the equipment with no further obligation, or he may continue leasing at one-third the original monthly rate. Typical machine tools and accessories available on lease include turret lathes, form grinders, and a numerically controlled positioning table for a jig borer. Other items are shown in the accompanying photographs.

Jones & Lamson officials believe that the growing need to increase industrial productivity in the U. S. will spark major interest in equipment leasing. Their plan is expected to have particular attraction for smaller industrial concerns who often find difficulty in accumulating capital to replace obsolete equipment or expand production.

While the plan will not of itself cause obsolescence, it will permit manufacturers to replace outmoded or worn machines more frequently than in the past. Thus, it should help alleviate the present situation where an estimated 45 per cent of all machine tools in use have been installed for 15 years or more. Continued use of this old equipment, of course, deprives industry of interim advances in machine tool design and productivity.

In connection with the lease plan, Jones & Lamson recommends use of its "avoidable costs" replacement formula to determine which equipment items should be replaced and which retained in service. The formula is claimed to give realistic answers to replacement problems, since it contains factors allowing for the current rising trends in labor, materials, and machinery replacement costs.

According to **Holmes H. Whitmore,** executive vice president of Jones & Lamson, money for extensive modernization of facilities usually comes from retained earn-

ings or venture capital. Taking money from retained earnings reduces working capital, and obtaining it as veture capital dilutes stock ownership. Leasing is designed to overcome the objectional features of both of these methods.

Growing Equipment Complexity Sparks Reliability Study

STUDY underway at the National Bureau of Standards is aimed at developing improved mathematical techniques for the evaluation and prediction of reliability of complex systems. Current trend toward increased complexity of electronic computers, automatic control systems, and missile instrumentation promises to rank reliability among the major problems facing industry and technology.

Many unknown and uncontrollable factors influence the performance of complex systems. Accordingly, some aspects of reliability determination require the development and use of probabilistic and statistical methods. Long-range goal of the NBS program, therefore, will be to develop a variety of approaches to the construction of mathematical models representing complex systems. Emphasis will also be placed on studies of interdependence between subsystems and techniques for analyzing experimental data on the reliabilities of components.

Computer Designs Computer At Minneapolis-Honeywell

EARLY in the planning phase for Minneapolis-Honeywell Regulator Co.'s new Honeywell 800 electronic data processing system (see AUTOMATION—March, 1959, p. 14), it was recognized that many of the design, engineering, and manufacturing functions that would be involved were in themselves forms of data processing. Accordingly, engineers and scientists responsible for the development of the complex, transistorized EDP system decided to use an existing Datamatic 1000 EDP system as a major timesaver.

K. C. BUTTERFIELD

W. W. KUYPER

R. L. SCHOENBERGER

W. A. STADTLER

Panel Session On Costs To Open Fourth Automation Conference

FIRST SESSION of the Fourth Conference on Manufacturing Automation will convene on the campus of Purdue University, Lafayette, Ind., on Monday, April 11, 1960. A highlight of the 3-day program will be the opening event, in which a panel of buyers and sellers of special automatic production equipment will discuss *Engineering Costs—Who Pays?*

Idea for a panel session on this topic was sparked by the popularity of an article entitled "Engineering Automated Equipment—Who Pays?" that appeared in the November, 1959, issue of AUTOMATION. The high readership interest shown in this article impressed on the conference planning committee the great value that a "live" discussion of the topic would have for both management and engineering people.

One of the strongest attractions of specially engineered automatic equipment is the production cost advantage it can give manufacturers over competitors who are using conventional machines. But the costs of developing and proving in special equipment are difficult to predict, and sometimes come out embarrassingly high.

Should the vendor absorb these engineering costs in his machinery pricing scheme? Or should users be expected to pay for this type of engineering on a per hour basis? Would a cost-sharing plan be best? The panel members will draw upon their experiences as buyers and sellers of special equipment and give their thoughts on equitable arrangements for transacting business in this market.

Buyer representatives are: **K. C. Butterfield**, staff master mechanic, Chrysler Corp.; **W. W. Kuyper**, manager, Manufacturing Engineering, Large Steam-Turbine Generator Dept., General Electric Co.; **R. L. Schoenberger**, manager, Production Engineering Dept., R. R. Donnelley & Sons Co.; and **W. A. Stadtler**, Director of Manufacturing Research, International Business Machines Corp.

Presenting the case for sellers will be: **J. R. Barefoot**, president, Federal Machine & Welder Co.; **Leo Gajda**, vice president, Snyder Corp.; **E. McFerren**, vice president-sales, Giddings & Lewis Machine Tool Co.; and **W. K. Stokes**, vice president-sales, Alvey Ferguson Co.

Additional details of the Fourth Conference on Manufacturing Automation will be found on page 158. Plan to attend this event.

J. R. BAREFOOT

LEO GAJDA

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DfI—Cleveland's Automatic Transistor Test Set eliminates manual inspection. Promised: a major reduction in manufacturing cost.

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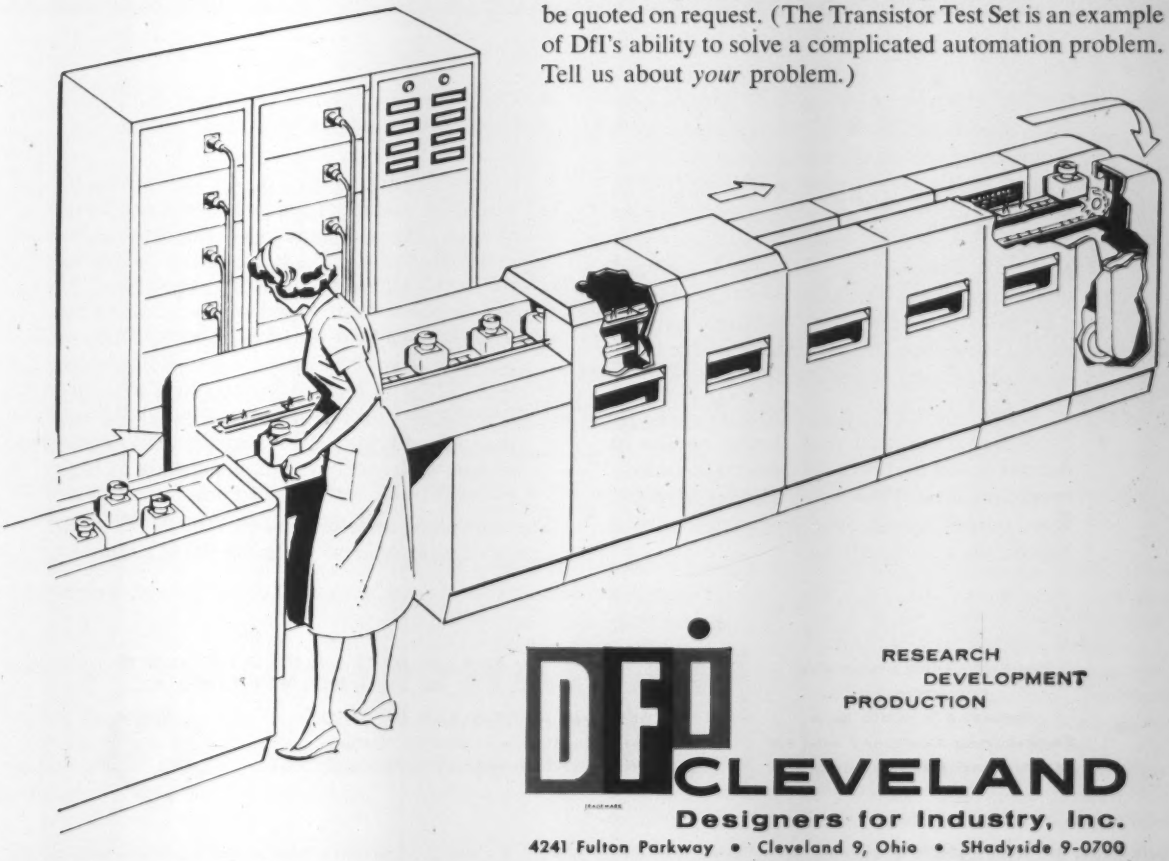

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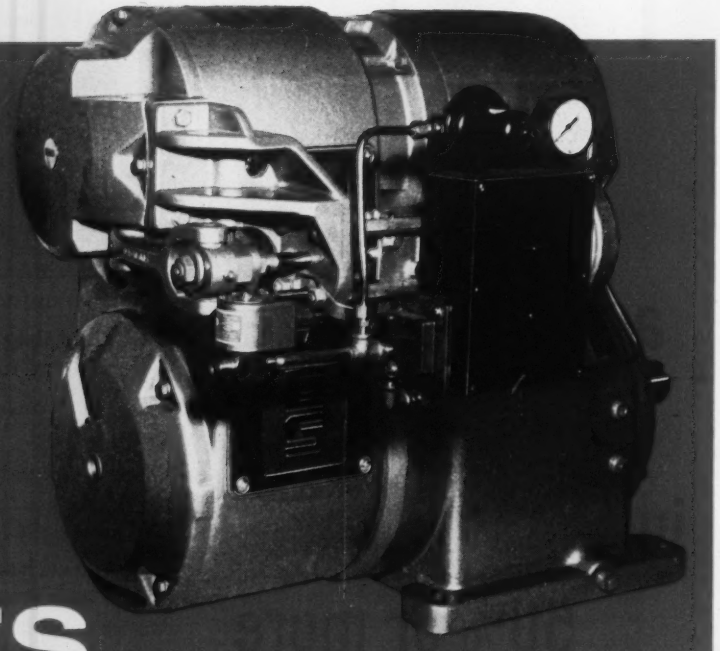
AIRtrol: automatic process control with REEVES VARI-SPEED MOTODRIVES



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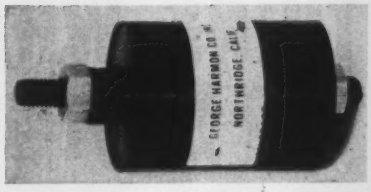
AUTOMATION NEWS

Walter W. Finke, president of Datamatic Div., estimates that use of the computer will save a minimum of 6 months in the engineering and design departments alone from the time of the original conception of the new system through testing out of the first prototype. First deliveries of the Honeywell 800 to customers are scheduled for October, 1960.

As an example of the economies that have been effected, some 10,000 drawings of electrical circuits that otherwise would have been required have been replaced by lists of tables and symbols recorded on magnetic tape by the Datamatic 1000.

Once the information from the tables was available on tape, engineers could rapidly check the circuits out for several characteristics. For example, noise pickup arising from congestion of any of the 60,000 wires in the system could be pretested in hours instead of days. Timing errors could also be checked without the necessity of studying masses of wiring diagrams to find the fault.



SOLID STATE time delay switching device has no moving parts, is capable of switching up to 50 amperes. Hermetically sealed unit, developed by George Harmon Co., is only 1¼ inches in diameter and 2 inches long. Device operates on 24-31v dc and requires maximum input current of 50 ma. Terminals include two threaded lugs and a solder lug.

In the manufacturing phase of the project, almost half the work of assembly can be simplified and made more efficient through use of computer-written wiring charts instead of blueprints.

Standardization Planned For Office Machines And Computers

AS A RESULT of a recent conference held under the auspices of the American Standards Association, first steps have been taken toward international standardization of office machines and data processing equipment.

At the conference, representatives

Automatic Techniques Improve Television Programming

IMPROVED operations with fewer personnel have resulted from the adoption of punched tape programming controls and remotely controlled cameras in the new studios of WKRC-TV, Cincinnati television station of Taft Broadcasting Co.

In operation of the system, a full day's programming is punched into 1-inch wide tape on a Flexowriter typewriter. When the tape is fed to a tape reader in a master control room, switching operations occur automatically in accordance with the patterns of perforations in the tape. Equipment that can be actuated by the tape includes eight sound-on-film projectors, four slide projectors, two audio turntables, two remote cameras, and four microphones.

For scheduled events, the tape reader is controlled by a master clock mechanism which advances the tape at definite times. However, for events where actual starting times cannot be precisely determined ahead of time, the tape can be advanced by an operator at a pushbutton station.

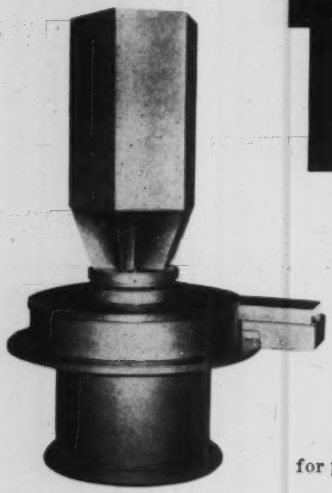
Studio cameras that have been preplaced in advance of a given program are controlled remotely during the program from the master control room. By manipulating a single lever, an operator can control vertical and horizontal motion of each camera while monitoring the program. Panel controls also permit remote adjustments for depth of focus, scanning, and pan shots.

MASTER control room of television station WKRC-TV where camera control, monitoring, and automatic programming functions are centralized. Tape reader at left supplies cuing information to data processing and storage equipment that actuates film projectors, slide projectors, audio tape and turntable units, cameras, and microphones.

An interesting automatic feature of the projection apparatus is use of a film loop storage chamber for repeated single announcements. Each time an announcement is programmed, its film loop completes one cycle and stops until it is again cued. Previously, repeated announcements required the preparation of multiple film strips.

Centralization of camera control, monitoring, and cuing functions at a single control point has resulted in a smoother, more logical flow of information and fewer errors in coordinating the many audio and video elements of each day's television program.

THINK WHAT YOU, TOO, COULD DO WITH A VERSI-TABLE TOOL TREE



THE VERSI-TABLE TOOL TREE grows out of an advanced concept of synchronous multiple machining operations based on unrestricted rotary indexing. Work units of your own determination branch out from the upright steel trunk, with the Versi-Table index set to as many work stations as required. Design and dimension of the Versi-Table Tool Tree conforms, in each instance, to the particular job specifications, with full latitude allowed for almost unlimited diversification. Positive precision indexing is accurately adjusted to each fixture, and the automated work flow is without flaw or hindrance. A matter of special appreciation is the round-the-trunk accessibility so conveniently provided by the Versi-Table Tool Tree. Let Savage Engineers confer with you on what you would like to accomplish with this low-cost method of multiple machining sequence, — the outcome may well be what you need for eliminating a production bottleneck, for increasing production, for lowering production cost, and for placing your business in a more favored position. What Savage Engineering is doing for others, it can also do for you,—and no obligation is attached to finding out.

VERSI-TABLE

CAN DO THINGS NO OTHER MECHANICAL ROTARY INDEXING METHOD CAN DO!

A whole new range of rotary indexing applications — with increased efficiencies never before possible — is opened up to you by Versi-Table and its Vari-Fine adjustment. The functions of rotary indexing are multiplied because the arbitrary limitations are no longer present.

In short, Versi-Table does things no other mechanical rotary indexing method can do.

You can set Versi-Table on odd and/or even spacing, thereby having all the stations on the full circle of the table at your disposal. You can make the settings, and change them as much as you please for all your various jobs.

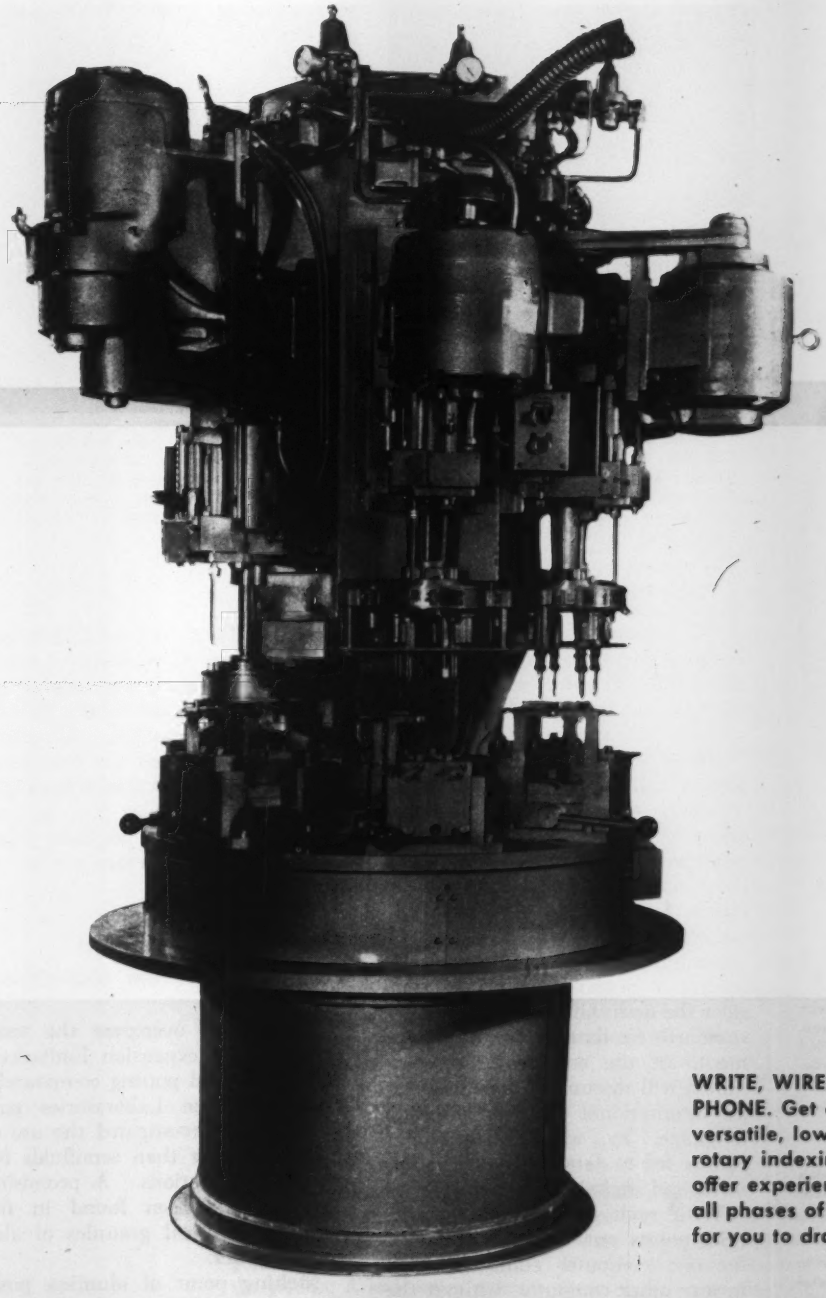
You can adjust the index to the fixture instead of having to make the fixture conform to the index for accuracy. On each of the selected stations you have from 0 to 15° to obtain precise indexing position.

You can obtain your own measure of precision through the Vari-Fine adjuster — quickly, conveniently, and accurately. By the same means you can also adjust out any deviation that occurs through wear.

You are sure of a positive stop on each station, with cushioned control on the positioning end of the index.

You can work to variable indexing speeds.

These, and other, exclusive features spell out for you a versatility that can be translated into new efficiencies and cost savings such as greatly improve your production profit. Versi-Table, either as an individual unit or incorporated in a TOOL TREE, may be specified to the size required, either air or hydraulically operated. Full details and engineering consultation gladly — and freely — given. Inquire, now, — take steps, now, to find out how Versi-Table can do more for you than any other mechanical rotary indexing method.



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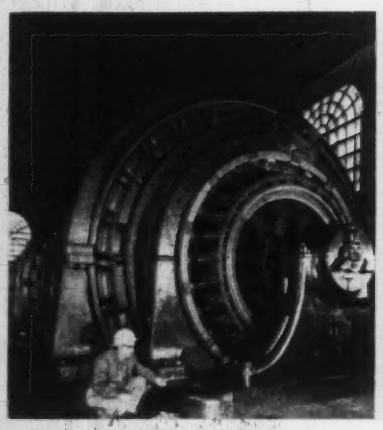

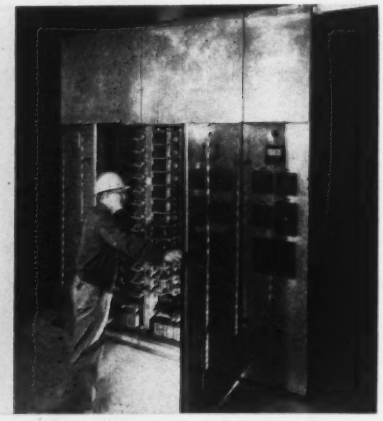

COMPACT ac to dc silicon rectifier, right, is rated 6000 kw at 600 volts and has an efficiency of 97 pet cent. Developed jointly by Aluminum Co. of America and Westinghouse Electric Corp., the static unit is one-third the size of the rotary converter, left, that has an output of 6825 kw at 525 volts. Approximately 60 per cent of the weight of the rectifier is aluminum, used for conductors, heat sinks, hardware, and the cubicle enclosure. All equipment shown is installed at the Badin, N. C., smelting works of Alcoa.

of 27 organizations recommended that two standards projects be initiated—one for office machines and the other for data processing equipment including digital computers.

Objective of the office machines project will be to standardize terminology and definitions of functions for office machines. Other fundamental areas of interest to users and manufacturers, such as output formats, will also come under scrutiny.

An international round-table conference was recommended to consider the desirability of international standards for data processing equipment. At the conference, a committee will discuss the possibility of an international code, or machine language, by which information can be fed to data processing equipment and digital computers.

With such a standardized code, ASA points out, data programmed for one computer could be used in any other computer, without the necessity for recoding. Thus, computer operators could work with any computer with a minimum of lost time for retraining.

Package Conveyor Institute Elects New Officers

ANNUAL meeting of the Package Conveyor Institute was held in Detroit, and new officers were elected to serve during 1960. Included are **Oscar Lund**, general manager of Arrow Products Inc., as PCI president; **George Greenberger**, president of Sage Equipment Co., as 1st vice president; **Carl Sheets**, manager, Conveyor Div., American Monorail Co., as 2nd vice president; **Robert Keen**, district sales manager for E. W. Buschman Co., as secretary; and **Lloyd G. Backart**, president of Rapistan-Keystone Co., as treasurer.

Dry Insulating Material Permits Component Inspection

SEEKING to overcome the temperature and expansion limitations of conventional potting compounds, Bell Telephone Laboratories personnel have investigated the use of materials other than semifluids for potting applications. A promising material has been found in the form of spherical granules of alumina powder.

Melting point of alumina powder is over 2700F, well above the operating temperatures of any electrical apparatus. It does not expand or contract to any noticeable extent under wide fluctuations of temperature, therefore no strains are imposed on the component. Also, curing or vulcanizing are not required to prepare alumina powder for use. Thus, no strains develop from these processes.

The powder possesses another advantage over asphalts, epoxy resins, and other common potting

around the triangle

MAINTENANCE SKILLS VITAL TO AUTOMATION

A new kind of maintenance man—namely, a highly trained engineer-technician who can cope with complex electronic control systems—will be needed to keep production flowing in automated factories of the future, according to James J. Durkin, general manager of the Service Shops Dept., General Electric Co. Speaking at a recent sectional meeting of the Association of Iron and Steel Engineers in Detroit, Mr. Durkin pointed out that the proportion of maintenance workers to total workers is rising and will have to increase drastically in the years ahead. The number of highly trained maintenance men able to troubleshoot and repair computers and programming controls must also rise sharply.

RADIOISOTOPE INVESTMENTS PAY BACK TEN-FOLD

Recent survey of industrial companies licensed to use radioisotopes, conducted by the National Industrial Conference Board under contract with the Atomic Energy Commission, shows that industry's investment in radioisotopes and equipment in 1957-58 was repaid ten-fold in measurable dollar benefits. The survey report includes chapters describing principal applications of radioisotopes in each of 20 major industries, with specific savings data for each industry. Uses of radioisotopes covered in the study include gaging, radiography, and tracing. Conclusion drawn is that many more industries could avail themselves of the savings offered by radioisotope techniques.

STATIC UNITS COOL BELOW AMBIENT

Thermoelectric modules developed by Westinghouse Electric Corp. are designed to cool electronic components used in industrial and military equipment. Unlike conventional heat dissipating devices that use air as the cooling medium, the modules can cool components below ambient temperature. Having no moving parts, the small, rugged devices may be mounted in virtually any position and even be combined to form simple structures such as cooling boxes. Powered from a low-voltage dc source, the cooling rate of a given module is a function of the power input and the temperature difference between its hot and cold surfaces.

PENCIL STUBBER COLLECTS QUALITY CONTROL DATA

Pencil manufacturers are deeply concerned with producing "leads" that do not break easily, for they realize that few things are as exasperating as a broken pencil point at a crucial moment. Vital to this objective is continuous quality control of the product. A lead testing machine developed by Instron Engineering Corp. facilitates quality control by automatically feeding lead samples from a magazine, breaking them, and printing out breaking strength data. Instrumentation for the device includes a pen recorder, a Datex Corp. shaft position encoder and control chassis, and a printer.

WELDS DIFFICULT MATERIALS WITH LOW POWER

Welding process that combines the advantages of capacitor discharge-spot welding and percussion welding has been announced by Weldex Div., Metal/Craft Co. Called "spike" welding, the method is capable of producing 500 welds per minute with 100,000 ampere pulses of 1 millisecond duration. The short pulses minimize temperature buildup in the work, so that studs, clips, and brackets may be welded to materials such as lacquer coated and vinyl-clad steels without damage or discoloration to the finish. Principle involves arranging capacitors so that they give 120 short duration pulses per second, with correspondingly low line demands.

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AUTOMATION

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For your convenience, advertisements and items of information on new equipment, components and manufacturers' literature can be quickly identified by an *Item Number* accompanying each unit.

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AUTOMATION **March, 1960**

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406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
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424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
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436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	769	799	839
440	480	520	560	600	640	680	720	760	800	840

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How Big Is A Tera?

PREFIXES for denoting multiples and submultiples of units, recommended by the International Committee on Weights and Measures, are aimed at unifying nomenclature in all fields. As evidence of their acceptance, the National Bureau of Standards recently adopted eight of the prefixes covering the range 10^{6} to 10^{-6} (mega to micro). As an example of use of the prefixes, 10^{-12} farad would be called a picofarad and symbolized 1 pf. The complete set of prefixes is:

Multiplier	Prefix	Symbol	Multiplier	Prefix	Symbol
10^{12}	tera	T	10^{-1}	deci	d
10^{9}	giga	G	10^{-2}	centi	c
10^{6}	mega	M	10^{-3}	milli	m
10^{3}	kilo	k	10^{-6}	micro	μ
10^{2}	hecto	h	10^{-9}	nano	n
10	deka	dk	10^{-12}	pico	p

compounds. That is, it maintains its dry, granular form in use. The electrical component can thus be removed for inspection or repairs simply by breaking the seal on the can and pouring out the powder.

Alumina is completely inert, so that there is no fire hazard either during potting operations or in use. Since alumina is stable at high temperatures, it can be used as a single potting compound to cover all operating temperature ranges. Its cost is competitive with that of conventional materials.

Crewless Locomotive To Be Controlled Remotely

PRACTICABILITY of operating an industrial switching locomotive without a crew, from a remote control point where the unit can be seen, is being investigated by Plymouth Locomotive Works, Div., Fate-Root-Heath Co. Equipment on order from Union Switch & Signal, Div., Westinghouse Air Brake Co., will permit remote starting, speed and direction control, and stopping of the locomotive. Provision is also made for remote shutoff of the engine, and operation of a track sander and a whistle.

Apparatus to be installed on the locomotive includes a radio frequency carrier receiver, a tone amplifying and demodulating unit, and control relays. This equipment will be operated from the 24-volt battery on the locomotive. Control point equipment will include a radio frequency carrier transmitter, a tone oscillator, and an array of switches and pushbuttons for selecting and initiating control actions. The remote control equipment will be offered as an optional feature available with the company's industrial switching locomotives.

Teflon Resin Can Be Molded And Extruded

COMMERCIAL production of a new plastic, designated Teflon 100, has resulted from a long-term research study by E. I. duPont de Nemours & Co. chemists to develop a tough polymer resin that could be processed on standard thermoplastic molding and extruding machines. The new material supplements the company's regular line of tetrafluoroethylene-type Teflon resins which must be processed by techniques similar to those used for powdered metals.

Teflon 100 is virtually immune to chemical attack, has excellent electrical insulating and frictional characteristics, and will not absorb moisture. Parts fabricated from the resin can be used in continuous service at temperatures up to 400 F.

Specific uses for the new material include jackets for coaxial and multiconductor cables, electrical wiring insulation, molded electronic components, tubing, and chemical equipment linings. Films made from the material are expected

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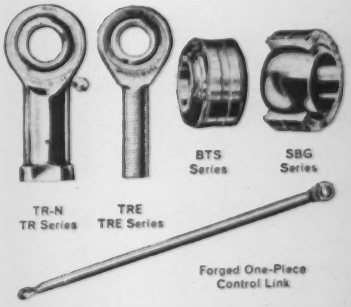
If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.



WRITE FOR BULLETIN 257

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A PRODUCT OF
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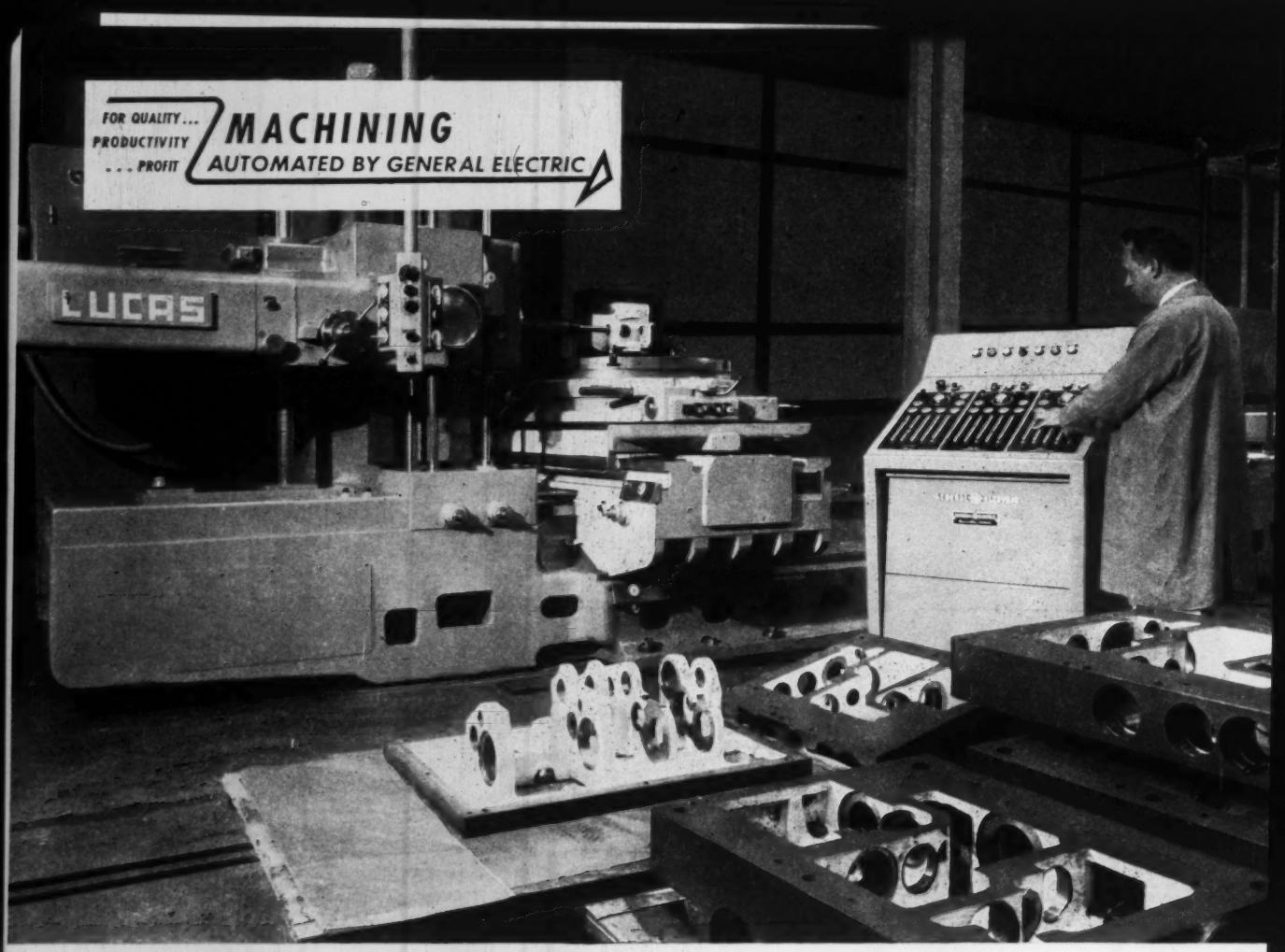
STEPHENS-ADAMSON MFG. CO.
22 RIDGEWAY AVE. • AURORA, ILL.

Circle 663 on Page 19



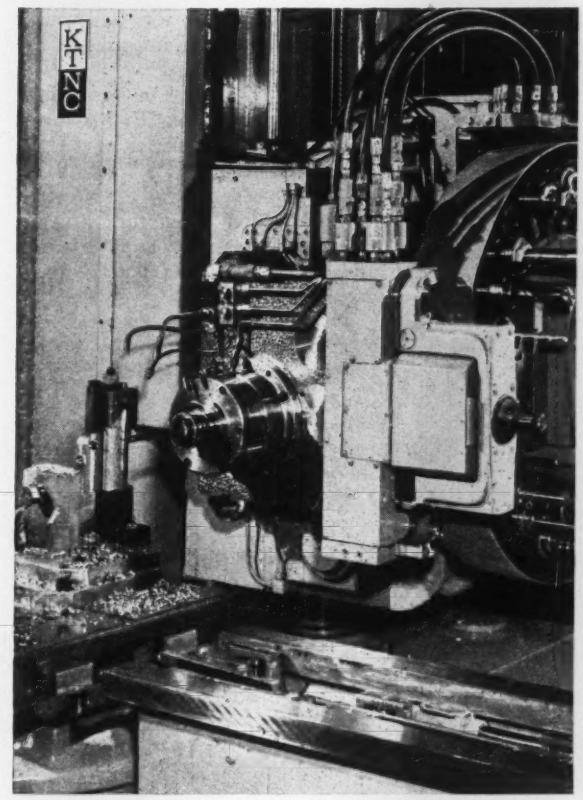
INCREASE MACHINE UTILIZATION

MARK SERIES NUMERICAL CONTROLS.....standard, job-proved packages now in use on a wide variety of machines

General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions — are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.



ONLY ONE SETUP NEEDED to produce even highly complex parts on this G-E controlled multi-purpose milling, boring and drilling machine means dramatic savings. And, tooling savings on one group of 6 parts totaled $10,000.

83% LEAD-TIME REDUCTION is average for parts produced on this 6-spindle turret drill directed by G-E numerical control. Tooling costs are 40% of former methods. Tape data-storage saves expensive tooling space.

with General Electric numerical control

Move quickly from part to part, cut non-productive machine time

An idle machine . . . and an investment going to waste! This is the case in plants throughout metalworking today—perhaps including yours!

Many reasons are apparent: tool-room lag in making fixtures; long setups during changeover; excessive manual positioning; or, poor machine scheduling due to manual operation. Whatever the case, this adds up to something you cannot afford: high unit costs.

But, there is a solution! General Electric numerical control on today's modern machines provides increased machine utilization that signals the end of long lead times . . . multiple setups . . . long machining cycles . . . and, excessive in-process inventories.

Reports prove the advantages of G-E numerical controls. One user states that with G-E controls, his milling, boring and drilling machine is making chips 55% more of the time . . . setup time is cut 40% . . . and positioning time is 50% less. All this—plus a major reduction in parts inventories made possible by G-E tape control's ability to exactly reproduce a part at any future time—enabled this user to pay for his numerically controlled machine in less than two years.

In another case, a new multi-purpose milling machine—directed by G-E numerical control—selects 31 different tools automatically. Non-productive machine-cycle time is virtually eliminated, and complete part machining is possible on a *single* setup. On one small-lot part, 749 hours were saved. Tooling savings on a group of 6 different parts totaled over $10,000.

Join with these and hundreds of users who are increasing machine utilization and worker productivity, and eliminating special tooling cost with G-E numerical control. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va. 795-8

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 664 on Page 19

You can automate from bin to batch with Richardson equipment

Whether your requirements are large or small, a Richardson Select-O-Weigh automatic proportioning system offers you the advantages of – **1.** Savings in labor costs. **2.** Increased productivity. **3.** Quality control. **4.** Better housekeeping. **5.** Permanent printed records. Incorporated into and governed by a Select-O-Weigh System are such units as –

Feeders – Designed to handle your material quickly and quietly – hundreds in use on all kinds of products.

Scales – Richardson Automatic Scales are known for speed and dependability. Any number can be remotely controlled by a Select-O-Weigh system.

Controls – Program your production and processes by punched card, formula board, formula capsule or weight-selector verniers. Only Richardson offers all four. Control is from a single electronic panel board, operated by one man. No special training is required.

Readout—Richardson furnishes counters, totalizers, printers, typewriters and recorders of all types.

Richardson's nationwide network of service facilities is at your disposal within 24 hours if required. Likewise, Richardson helps you at start-up of your system and thoroughly checks it in operation. For full details on how you can automate your processing with Richardson equipment, write or call today. 1791

Richardson Scales conform to U.S. Weights and Measures H-44 for your protection.

Here's the answer . . .

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

RICHARDSON SCALE COMPANY • CLIFTON, NEW JERSEY

Sales and Service Branches in Principal Cities • Also manufactured in Europe to U. S. Standards.

to find wide use for coil-wound products, capacitors, and printed circuit applications.

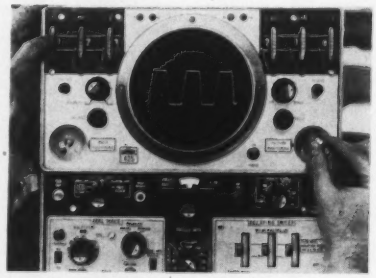
Available from a Du Pont plant in Parkersburg, W. Va., natural color material is priced at $11.60 per pound in truckload quantities. It can be processed by screw extrusion; injection, compression, and transfer molding; vacuum forming; and fluidized bed coating techniques.

The material may be reinforced with up to 20 per cent by weight of inorganic fillers and still retain its processing characteristics. With glass fiber as the filler, stiffness and wear resistance are increased and thermal coefficient of expansion is reduced.

Environment Important To Machine Tool Accuracy

TO HELP realize the capability of its Numera-Trol contouring machine to turn out extremely accurate work, Ex-Cell-O Corp. has found it desirable to control the environment in which the machine is used. For example, by operating the numerically controlled machine at a constant 72F, it is possible to hold work tolerances of 0.0001 inch in routine production of templates and 0.0002 inch in contouring operations.

Both the main slide and cross slide assemblies of the machine are controllable in increments of 0.000025 inch, either automatically through tape control or manually during setup. Heat from the elec-



OSCILLOSCOPE developed by Allen B. DuMont Laboratories Inc. provides digital readout of waveform voltage and time values. Adjustment of thumbwheels to move a luminous scaling dot to a point of interest on a waveform also controls the digital display. Electrical outputs provided by the unit may be connected to computers, printers, and punched card or tape machines for process control and data handling purposes.

Circle 665 on Page 19

ADJUSTABLE STROKE SAVES TOOLING

Now—put pressure where it's wanted instantly and cheaply—with Mead's powerful midget air cylinders (1" bore, single-acting, spring return). Stroke is adjustable to exact length required, even after components are locked in place. Use them singly or in groups to move, hold, press or eject small work pieces; to close and open large jigs, forms, fixtures. Actually they will replace human fingers and mechanical clamps in innumerable routine jobs.

NEW MIDGET AIR CLAMPS

(SPRING RETURN AIR CYLINDERS)

NEW! SAVES TIME! These outstanding Air Clamp cylinders with adjustable strokes variable from ½" to 3" can be "tuned" to exact length wanted even *after* setup is made! This feature alone saves hours of time designing, laying out special jigs, fixtures. **NEW! SAVES AIR!** You can conserve air in large fixtures (where dozens or hundreds of Midget Air Clamp cylinders are used) by using "just enough—no more" stroke. The shorter the stroke, the faster the cycle. **NEW! SAVE SPACE & MONEY!** The cylinder "nose" telescopes into barrel reducing stroke and overall length. All this at prices so low you can almost *forget* their modest first-cost. But you'll *remember* the countless man-hours saved—the lessened fatigue of your workers at monotonous jobs—the improved quality and accuracy of their work!

WRITE FACTORY OR NEAREST MEAD REPRESENTATIVE FOR BULLETIN

(See alphabetical index of Thomas' Register for address, phone number, or check the Yellow Pages.)

MEAD SPECIALTIES CO.

4114 N. KNOX AVE., DEPT. 230, CHICAGO 41, ILLINOIS

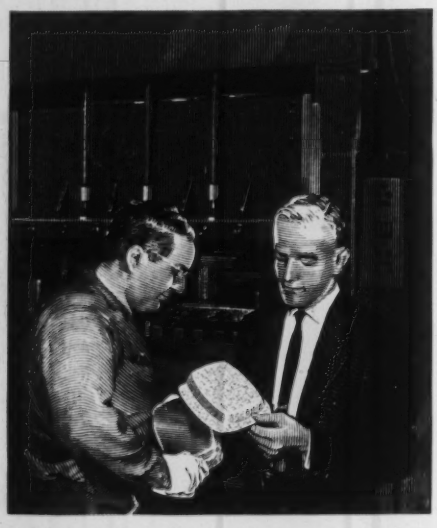
PATHFINDER IN AIR POWER AUTOMATION

Circle 666 on Page 19

To the Executive concerned with
the Cost of Retooling for Vinyl-Clad Metals...

Why shouldn't you fabricate CLAD-REX on existing tooling ...many others do!

Hard to believe, perhaps, but it's true. No exotic technique *or* complicated special tooling is needed to make your product with Clad-Rex vinyl-metal laminate. Because Clad-Rex can be fabricated in almost as many ways as any *un*finished



sheet metal. And, what's more, Clad-Rex offers, *without charge*, a Field Fabricating Engineer. He shows your shop people how easy it is to get into production.

There are two basic reasons why Clad-Rex vinyl-metal laminates are so practical:

1. Clad-Rex, unlike some other vinyl-clad metals, is a calendered, semi-rigid, poly-vinyl chloride film laminated to sheet metal.

That simply means Clad-Rex has unusual resistance to abrasion. Actually, Taber Abrader Tests (ASTM Standards) prove Clad-Rex is four times as rugged as linoleum floor tile.

2. Clad-Rex laminating is done under rigidly controlled conditions. The vinyl surface is there to stay. Even deep drawing is possible without delamination.

This quality control is supported by the Clad-Rex Research Laboratory—the only one of its kind in the field.

You can be sure Clad-Rex vinyl-metal laminates are practical, both in your shop and on your product. Unlimited styling, to improve the sales appeal of your product . . . unusual abrasion and corrosion resistance . . . a remarkable opportunity to reduce your manufacturing and finishing costs . . . a virtual end to the rejects common with other prefinished metals —*this* is Clad-Rex.

See for yourself. Write for details. No obligation, of course.

VINYL-METAL LAMINATES BY **CLAD-REX**® DIVISION OF SIMONIZ COMPANY

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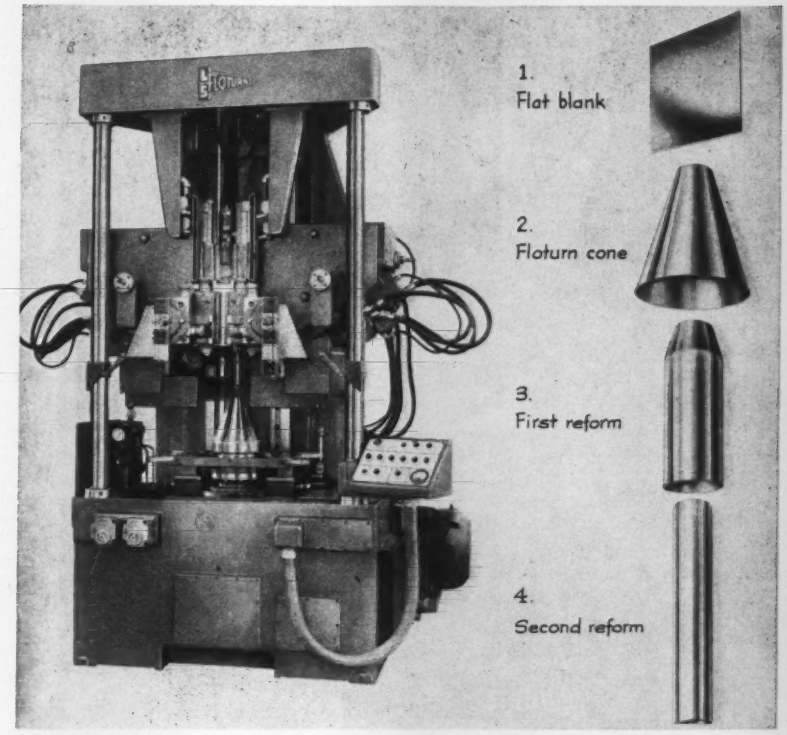
1-A

Circle 667 on Page 19



PROCESS developed by Lodge & Shipley Co. permits forming of long parts from flat blanks in fewer operations than would be required by deep drawing. First step involves forming of the blank into a truncated cone on company's Floturn machine (illustrated). Cone is then reformed as many as three times in special dies in a press. Diagram illustrates steps in the production of a stainless steel cylinder 2½ inches in diameter by 14 inches long from a 7½ inch square blank. Two reforming operations are required to finish form the part. If made by conventional deep drawing, part would require as many as nine drawing operations.

tronic equipment contained within the tape reading cabinets is ducted away from the work area, and the machine's hydraulic power unit is water cooled.

Controlled with pulse data input, the machine is capable of automatically performing precision turning, boring, and grinding.

SPOTLIGHTING PLANTS

Radio Corp. of America has formed an Industrial Computer Systems Dept. that will design, manufacture, and market industrial electronic computers. Principal product will be the recently announced RCA 110 computer for automatic control of processes in the petrochemical, power, and metal industries. . . . **Information Systems Inc.** is acquiring the operating assets of Panellit Inc., and then will become a subsidiary of Chance Vought Aircraft Inc. along with Genesys Corp. The moves will strengthen Chance Vought's position in the computer field. . . . **Westinghouse Air Brake Co.** is consolidating its Le Roi Div. operations (now carried out at several locations) into one operating unit at Sidney, Ohio. . . . **Burroughs Corp.** is establishing an Equipment and Systems Marketing Div. that will consolidate the marketing activities of its Burroughs Div. and ElectroData Div. . . . **Warner & Swasey Co.** has acquired a substantial interest in Wang Laboratories Inc., manufacturer of specialized electrical and electronic devices and components. . . . **Potter Instrument Co. Inc.** has sold and transferred its electronic counter business to the newly formed Electronic Counters Inc. . . . **Bell & Howell Co.** has acquired Consolidated Electrodynamics Corp., which will continue to operate under its present name. . . . **Cosden Petroleum Corp.** has announced plans to erect facilities that will triple its

Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeable with the brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the telephone type "E" relay are—

Contact spring assembly: maximum of 20 Form A, 18 B, 10 C per relay.

Coil: single or double wound, with taper tab or solder type terminals at back of relay.

Operating voltage: 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 111 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

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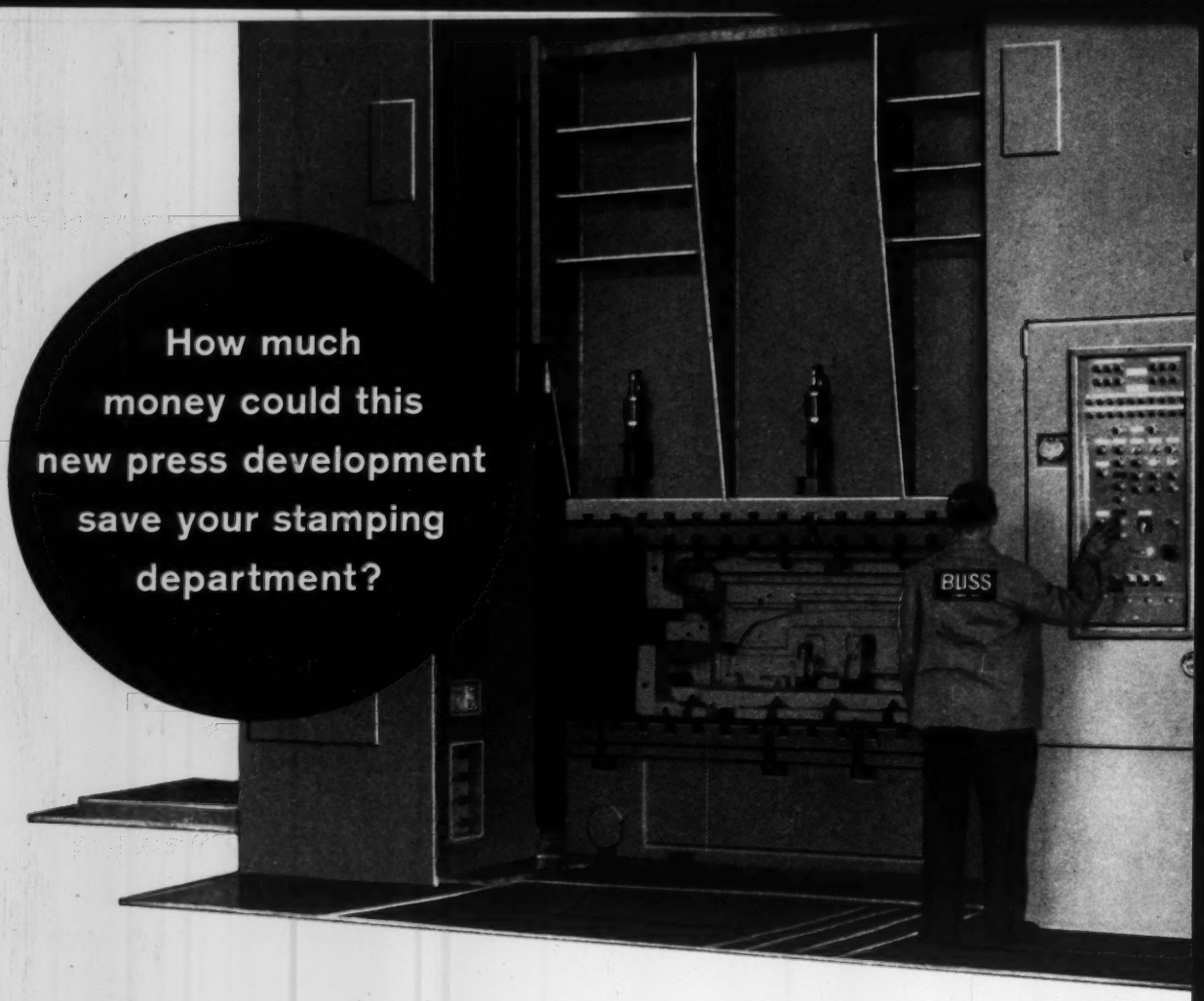

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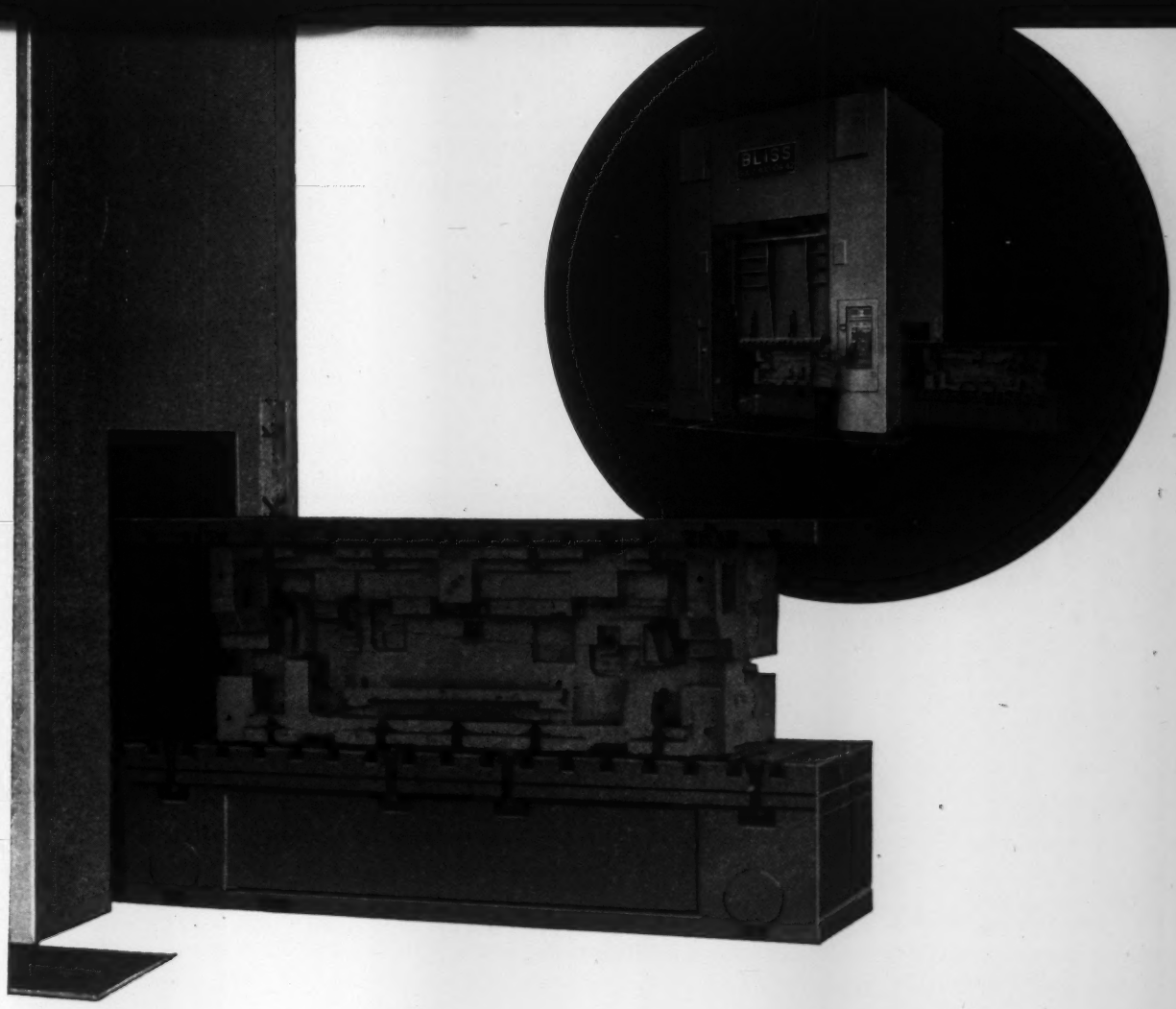
BLISS is more than a name... it's a guarantee

E. W. BLISS COMPANY, Canton, Ohio



Hailed as the longest step forward in large press design in the last twenty years, the new Bliss rolling bolster press outproduces an equivalent straight-side press by a ratio of 1¾-to-1. It raises press efficiency—the percent of the time the press is actually producing stampings—from an average of 40% to better than 90% of every working hour. More than twenty are already on order!

The new Bliss rolling bolster presses are far more than straight sides with something added. They have been redesigned throughout for high-speed operation. Some of their special features:

Automatic die clamps...driven by a push-button controlled torque motor. Six threaded T-bolts clamp or unclamp the dies in seconds. Electric interlocks protect the dies and press from damage.

Automatic ram positioner...positions ram electronically to any desired shutheight within .0015". It's fast and simple...you set the dials and push the button.

Hydraulic overload protection...guards against die damage. Press overload releases oil in unique system under pressure equal to a preset capacity. Press stops, warning lights flash.

Simplified gear train...has only four gears, fewer than any other underdrive press. This extremely low inertial load permits a very high tripping rate with minimum clutch wear.

Demountable gear case...comes off as a single unit, exposing all drive gears, clutch, brake and flywheel. Cuts hours from maintenance.

Link type press drive...develops extremely high mechanical advantage through links, rock shafts and pulldown rods. Rock shafts rock to within 5° of vertical alignment, eliminating press sticking at bottom dead center.

These overall design advantages and special features may save you money on many of the parts you are now producing on conventional presses. In total, they make up the most advanced and productive straight side presses ever developed... just one more result of Bliss' constant effort to design equipment to cut production costs to the bone. For detailed information, write us today.

PRESSES • ROLLING MILLS • ROLLS • DIE SETS • CONTAINER MACHINERY • CONTRACT MFG.

Circle 669 on Page 19

NEW CATALOG AVAILABLE

MERCOID® CONTROLS

Write for your copy

CONTENTS:

Controls for—

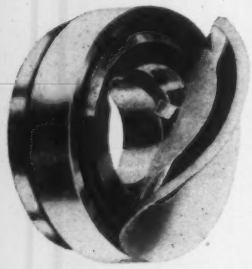
- PRESSURE
  TWO-STAGE PRESSURE
  DIFFERENTIAL PRESSURE
- TEMPERATURE
  TWO-STAGE TEMPERATURE
- LIQUID LEVEL
- MECHANICAL MOVEMENT
  LEVER ARM AND
  FLOAT OPERATED
- TRANSFORMER-RELAYS
- MERCURY SWITCHES
  HERMETICALLY SEALED

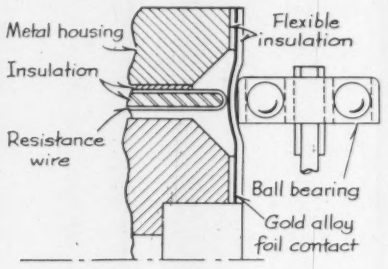
CATALOG NO. 860

THE MERCOID CORPORATION
4205 BELMONT AVENUE
CHICAGO 41, ILL.

IT'S EASY
TO SELECT A
CONTROL FOR
ANY APPLICATION
WHEN IT'S A
MERCOID®

Circle 670 on Page 19





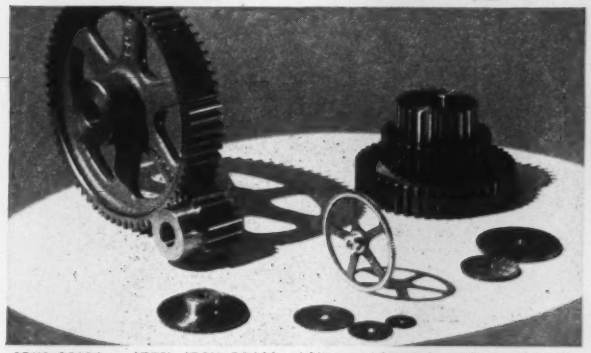
ROLLING-CONTACT design of rotary potentiometers manufactured by Technology Instrument Corp. eliminates wear effects experienced with conventional slider arrangements. As shown in the sectional view, a ball bearing on a radial arm distorts a flexible diaphragm to bring a small area of a gold alloy foil element into contact with the helically wound resistance wire. Tests have shown that the unit will withstand 85 million cycles at 500 rpm with no significant change in total resistance or linearity. Construction also provides hermetic sealing of the resistance element to exclude dust and moisture

styrene production capacity to 60 million pounds annually. Styrene is an important chemical building block for plastics and synthetic rubber. . . . **Sel-Rex Corp.** has purchased Meaker Co., manufacturer of automatic systems for continuous batch metal processing and finishing. . . . **Servo Corp. of America** has acquired Electro-Pulse Inc., which will become a subsidiary. . . . **Automation Industries Inc.** is the new name for Automation Instruments Inc.

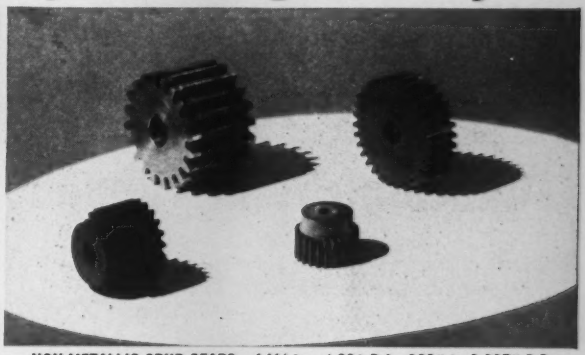
SPOTLIGHTING PEOPLE

Dr. E. G. Fubini elected vice president, Research & Systems Engineering Div., and **Dr. G. C. Comstock** elected vice president, Electronic Systems & Techniques Div., Airborne Instruments Laboratory. . . . **Gordon R. Anderson** appointed executive vice president, Operations, Fairbanks, Morse & Co., with responsibility for divisional manufacturing, engineering, and research. . . . **Arthur P. Jackel** named consulting engineer for Systems Engineering Section, General Apparatus Dept., Union Switch & Signal Div., Westinghouse Air Brake Co. . . . **William Bournias** appointed chief engineer of Buhr Machine Tool Co. . . . **Kenneth R. Geiser** named manager of business planning, **Dr. Robert R. Johnson** named manager of engineering, and **Dr. Helmut M. Sassenfeld** named manager of the applications section, for the Computer Dept., General Electric Co. . . . **George F. Topinka** appointed chief engineer of the Power Cylinder Div., Hannifin Co., Div., Parker-Hannifin Corp. . . . **Arthur J. Hatch Jr.** elected vice president and general manager of Special Products Div., Stromberg-Carlson, Div., General Dynamics Corp. . . . **Carl R. Lindell** promoted to plant manager of F. Jos. Lamb Co. with responsibility for co-ordinating machine tool design, engineering, sales, and manufacturing work. . . . **Richard A. Wallace** named manager of mechanical design and peripheral device engineering for the Electronic Data Processing Div., Radio Corp. of America. . . . **Harry C. Lingle** elected vice president in charge of engineering and production for Paslode Co., Div., Signode Steel Strapping Co. . . . **B. F. Gira** elected president and **R. V. Higdon** named vice president of United Industrial Corp., which now includes American Engineering Co., Detroit Stoker Co., Aircraft Armaments Inc., U. S. Science Corp., U. S. Semiconductor Products, and Micro Path Inc. . . . **Frederick M. Geiger** appointed manufacturing manager, Potentiometers, and **Joseph Katona** named manufacturing manager, Instruments & Systems, Daystrom Pacific Div., Daystrom Inc. . . . **George F. Lytle** appointed manager, Pressuregrip Div., Whiting Corp. . . . **Dr. William C. Leone** elected vice president and general manager of Rheem Califone Corp., subsidiary of Rheem Mfg. Co. . . . **Walter F. Friedman** named vice president of Dasol Corp. . . . **A. D. Lumsden** appoint-

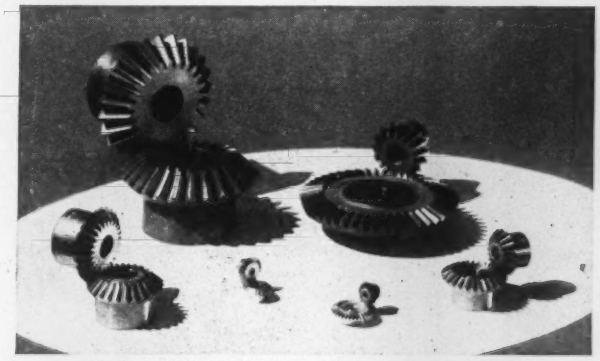
Design around gears you can get today



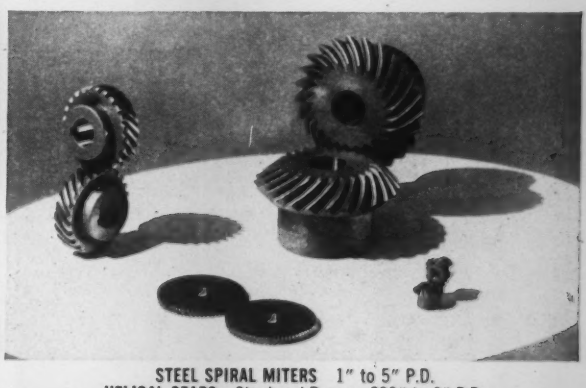
SPUR GEARS — STEEL, IRON, BRASS 14½° and 20° P.A. .208″ to 40″ P.D.



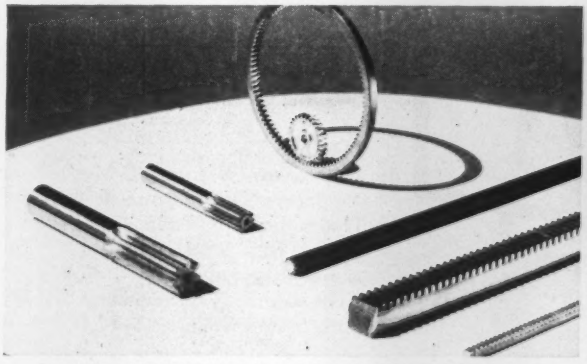
NON-METALLIC SPUR GEARS 14½° and 20° P.A. .938″ to 6.667″ P.D.



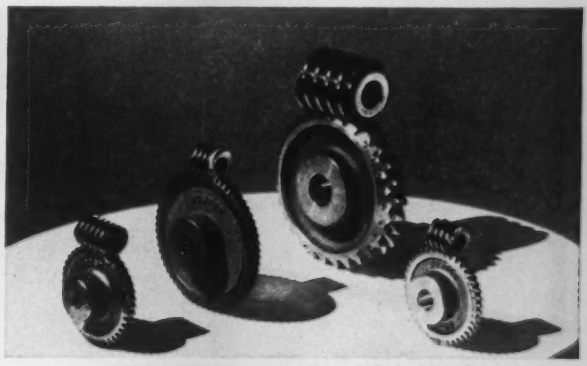
BEVEL and MITER GEARS Steel, Iron, and Brass 20° P.A. .312″ to 14″ P.D.



STEEL SPIRAL MITERS 1″ to 5″ P.D.
HELICAL GEARS Steel and Bronze .333″ to 6″ P.D.



RACK • PINION WIRE Steel and Brass 14½° and 20° P.A.
PINIONS • INTERNAL GEARS



WORM GEARS Bronze and Iron .417″ to 18″ P.D.
WORMS .333″ to 4″ P.D. Soft steel and hardened and ground steel

Build it better... for less...without delay

Design around standardized BOSTON Gears FROM STOCK is the quickest (and lower-cost) way to get your project "off the board" and in production — whether it's a prototype, a product for resale, or new equipment for your own plant. Catalog No. 57 lists over 2000 gears.

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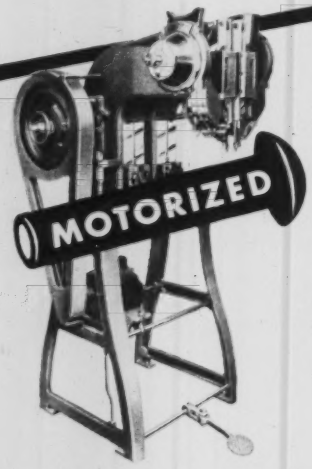
Circle 671 on Page 19

Why *Chicago Rivet* Offers TWO METHODS for Clinching Semi-Tubular Rivets

It is part of a widening service based upon industry's recognition that an assembly held together by semi-tubular rivets has great inherent strength and is usually lowest in production cost.



The Chicago Rivet MOTORIZED AUTOMATIC RIVET SETTER produces a sharp, solid blow that immediately upsets the tubular section. This method is used on 95% of all applications involving metals or non-fragile materials.

The Chicago Rivet AIRPOWERED RIVETER produces a cushioned, shock-free clinch on a tubular rivet, permitting riveting of fragile and uneven materials. This method has greatly widened the use of semi-tubular rivets.

FOR YOUR FILES

RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

AIR-POWERED RIVETING catalog contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automated operation.

Why not let Chicago Rivet Fastening Engineers tell you which system is best for you. No obligation.

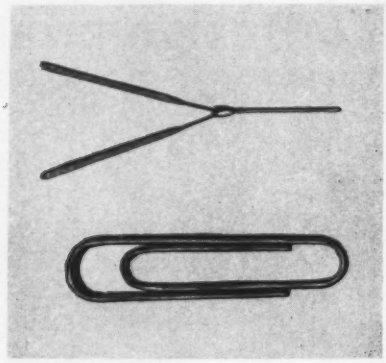
MOTORIZED

Line includes automatic single, multiple and automated setters.

AIR-POWERED

Line includes automatic single, multiple and automated setters.

Chicago Rivet
& MACHINE CO.
943 So. 25th Ave., Bellwood, Ill.
(Chicago Suburb) Branch Factory: Tyrone, Pa.



MONOFILAMENT strain transducer is designed for direct insertion in components and for use in tight spots. When inserted in axial holes in bolts, studs, rivets, and other fasteners, it will respond only to axial loads and be insensitive to torsion or bending. The small transducer, developed by High Temperature Instruments Corp., is suitable for high temperature applications and may be cast directly into plastics and some metals.

ed manager of operation for Wire Products Dept., Hewitt-Robins Inc. . . . **George R. Pipes** named assistant manager, **Harold A. Frost** appointed manager of product development, and **Joseph E. Urbassik** named automation manager of Central Research Div., Eaton Mfg. Co.

MEETINGS AND EVENTS

March 6-9—

American Society of Mechanical Engineers. Gas Turbine Power and Hydraulics Conference to be held at the Rice Hotel, Houston. Additional information can be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

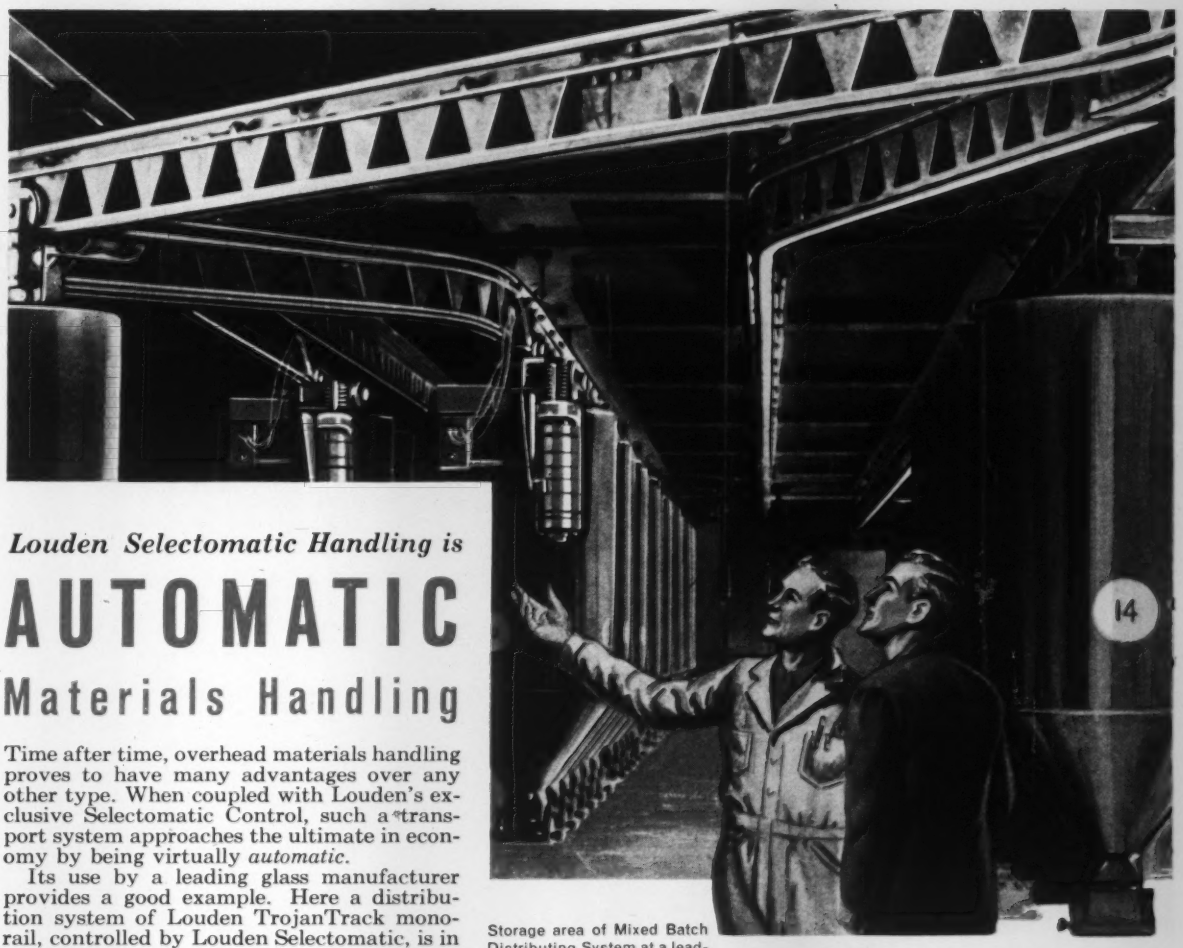
March 9-11—

Instrument Society of America. ISA Temperature Measurement Symposium to be held at the Deshler Hilton Hotel, Columbus, Ohio. Further information is available from William H. Kushnick, ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

March 21-24—

Institute of Radio Engineers. National Convention and Radio Engineering Show to be held at the Waldorf Astoria Hotel and the Coliseum, New York. Additional information is available from IRE

Circle 672 on Page 19



Louden Selectomatic Handling is

AUTOMATIC

Materials Handling

Time after time, overhead materials handling proves to have many advantages over any other type. When coupled with Louden's exclusive Selectomatic Control, such a transport system approaches the ultimate in economy by being virtually *automatic*.

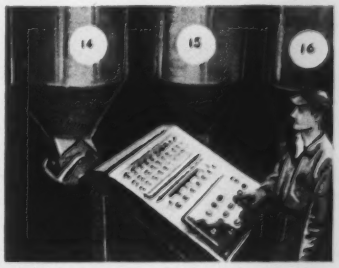
Its use by a leading glass manufacturer provides a good example. Here a distribution system of Louden TrojanTrack monorail, controlled by Louden Selectomatic, is in operation 24 hours a day. At the touch of a button, a gross live load of 33 tons is on its way . . . transporting its load of mix to a designated furnace automatically. Carrying thousands of tons of material daily, this system endures hard and heavy service with a minimum of maintenance attention.

This is just one of the many handling problems that have been solved with Louden Monorail. No other handling system permits such a wide diversity of uses. Over one universal handling system, easily installed and easily enlarged as occasion demands, your product can be handled from raw material to the wrapped package without one interruption to the smooth, even flow of production. Handling never becomes rehandling with Monorail.

Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have a materials handling problem or any plant problem involving lifting and transporting loads, call on Louden for suggestions. Your inquiry will receive prompt attention.

THE LOUDEN MACHINERY COMPANY
306 Broadway, Fairfield, Iowa
A Subsidiary of Mechanical Handling Systems Inc.

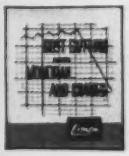
Storage area of Mixed Batch Distributing System at a leading glass manufacturing plant. Operating over the system are 29 Louden Selectomatic Moto-Veyor propelled trains of 6 batch cars per train.



Operator dispatching train. Trains load themselves, transport the load, store the load until needed, and then unload at the designated furnace all automatically.

Schematic drawing of Mixed Batch Distributing System at a leading glass manufacturing plant. This system consists of 2,400 feet of Louden TrojanTrack.

NEW . . . 52 PAGES
of illustrated applications
. . . industry by industry.

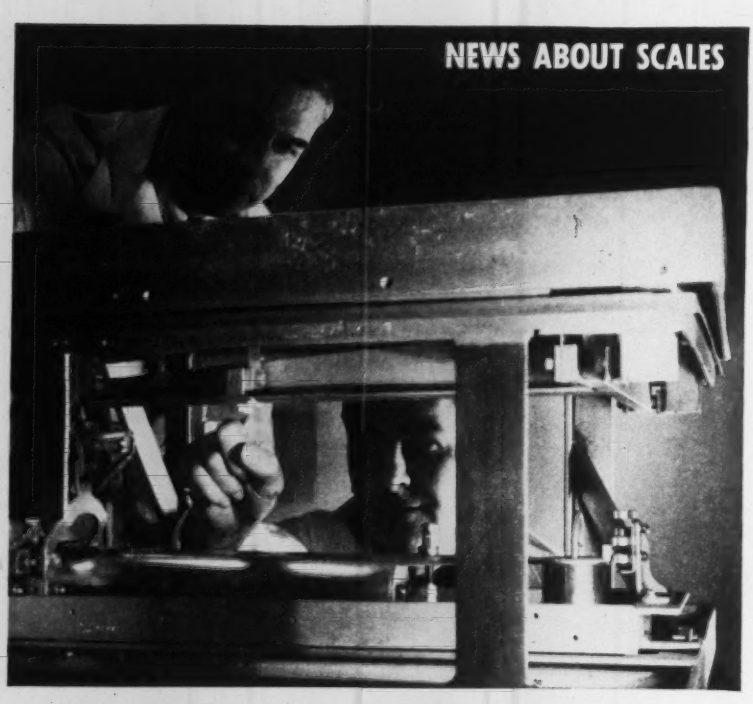


Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."

Louden
MONORAIL & CRANES

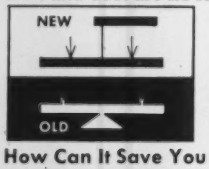
SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

Circle 673 on Page 19



How do they build unvarying accuracy into this remarkable new kind of weighing instrument?

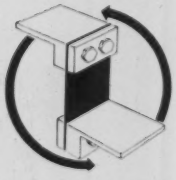
For 7,000 years men have employed the multi-part pivot balance to compare weights. As the parts of their pivot joints wore, the problem of retaining accuracy became more and more acute. Then in 1956 the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had devised a revolutionary new scale. Knife-edge pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem.



Thayer guarantees this leverage system accurate for the life of the scale.

How Can It Save You Money Year After Year?

Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.



THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. THAYER PARK, PEMBROKE, MASS.

Circle 674 on Page 19

headquarters, 1 E. 79th St., New York 21, N. Y.

March 22-24—

Society of Automotive Engineers Inc. National production meeting to be held at the Statler Hilton Hotel, Cleveland. For further details, contact SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

March 29—

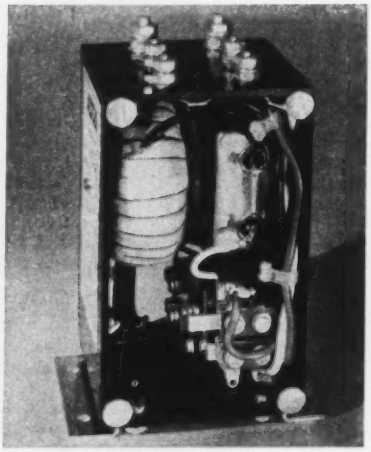
Material Handling Institute Inc. Spring Meeting to be held at Hilton Hotel, Pittsburgh. For further information contact W. L. Redding, Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

April 4-7—

American Management Association. 29th National Packaging Exposition and Conference to be held at Convention Hall and the Shelburne Hotel, Atlantic City, N. J. Additional information is available from AMA headquarters, 1515 Broadway, New York 36, N. Y.

April 4-8—

Nuclear Congress to be held at the Coliseum, New York. Congress includes the 6th Nuclear Engineering & Science Conference, the 8th NICB Atomic Energy in Industry Conference, and the 6th International Atomic Exposition. Further information may be obtained from 1960 Nuclear Congress, 33 W. 39th



SUITABLE for machine tool applications, mechanically held relay developed by Automatic Switch Co. employs a rotary solenoid and single coil construction. Operation by momentary energization of the coil minimizes ac hum and contributes to reliability of the unit. Multiple contacts are standard, and units may be hermetically sealed.

THE NEW NAME WITH THE FAMILIAR RING!

This new name combines three old names of the Induction Heating business—Ajax Engineering, pioneer in 60-cycle melting; Ajax Electrothermic, pioneer in high-frequency melting; and Magnethermic, pioneer in Induction Billet Heating.
This old "new" company now offers the most complete line of Induction Heating equipment, the most experienced staff and the largest facilities of any manufacturer of Induction Heating equipment. This combination of experience, facilities and product line permits an unbiased evaluation of your heating or melting application.

"induction heating is our only business"

AJAX Magnethermic CORPORATION

GENERAL OFFICES
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Youngstown 1, Ohio

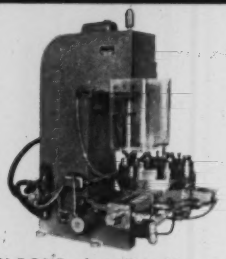
TRENTON DIVISION
930 Lower Ferry Road
Trenton 5, New Jersey

YOUNGSTOWN DIVISION
3990 Simon Road
Youngstown 1, Ohio

Circle 675 on Page 19

AIR-HYDRAULICS INCORPORATED

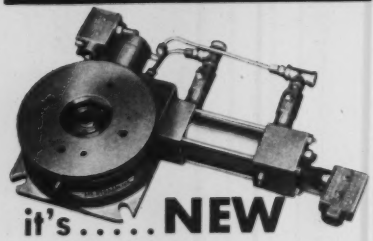
INCREASE PRODUCTION 50%



IT'S BEEN DONE—for a "big 3" auto company. Tooling shown increased production on press assembly of steering knuckles from 1200 to 1800 pieces per hour—with added operator safety. **COMPLETE SET-UP**—#1405 Air Index Table, #C-300 5½ Ton Press, controls and fixtures were furnished by Air-Hydraulics, Inc. An electrical circuit synchronizes press and table for fully automatic operation on standard line pressures. Operator places pieces on fixture outside guard • Parts are indexed into position and pressed together • Assembly is removed automatically and chuted into container. Constant pressure throughout ram stroke has eliminated previous trouble caused by variations in stock thickness and other factors.

AIR-HYDRAULICS INCORPORATED

LOW COST 7" INDEX TABLE



it's.....NEW

The heavy duty Model 700 is only 7" in diameter but has most of the features found on larger models • Makes up to 75 indexes per minute • Handles maximum work load of 100 lbs. • Maximum power stroke is 3 times line pressure • Operates on pressures from 60 to 175 p.s.i. • Clockwise rotation with either 4, 6, 8 or 12 stations standard • Others up to 24 stations and counter-clockwise rotation, to order • Bolt larger sub-plate (up to 14" dia.) to ground steel table for larger work area • Positive index—no override • Adjustable cushion and speed control • Each table checked for guaranteed accuracy of index (± .0015"), concentricity and parallelism.

WRITE NOW FOR FREE CATALOG AND PRICE INFO.

AIR-HYDRAULICS INCORPORATED

299 HUPP AVE.
JACKSON, MICHIGAN

Circle 676 on Page 19

LIVE rails of these Alvey-Ferguson Co. storage racks require no fastening to rack structure, may be moved laterally to accommodate packages of different widths. Design is especially useful in order picking applications where carton sizes are subject to frequent change. Equipment is installed in a warehouse of the Springday Co.

St., New York 18, N. Y.

April 5-7—

Instrument Society of America. Third National Chemical & Petroleum Instrumentation Symposium to be held in Rochester, N. Y. For additional details contact Director of Technical and Educational Services, ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

April 11-13—

Fourth Conference on Manufacturing Automation. Co-sponsored by Purdue University and AUTOMATION magazine, conference will be held at Purdue University, Lafayette, Ind. For additional information contact K. E. Glancy, Div. of Adult Education, Purdue University or AUTOMATION, Penton Bldg., Cleveland 13, Ohio.

April 18-19—

Third Annual Conference on Automatic Techniques. Sponsored by a national committee including representatives of ASME, IRE, and AIEE, conference will be held at the Cleveland-Sheraton Hotel, Cleveland. Additional details may be obtained from J. H. McRainey, publicity chairman, 1213 W. 3rd St., Cleveland 13, Ohio.

April 19-21—

American Society of Lubrication Engineers. 15th Annual Meeting and Lubrication Exhibit to be held at the Netherland Hilton Hotel, Cincinnati. Further information is available from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

April 21-28—

American Society of Tool and Manufacturing Engineers. Tool Show and Annual Convention to be held in the Artillery Armory and the Sheraton-Cadillac Hotel, Detroit. For additional information contact H. E. Conrad, ASTME headquarters, 10700 Puritan Ave., Detroit 38, Mich.

April 25-29—

American Welding Society. 41st Annual Convention and Welding Exposition to be held in the Biltmore Hotel and the Great Western Exhibit Center, Los Angeles. Further information may be obtained from AWS headquarters, 33 West 39th St., New York 18, N. Y.

For Literature on Hannifin Items, Circle 677→
For Literature on Fittings & Hose, Circle 678→

PARKER-HANNIFIN FLUID SYSTEM COMPONENTS

Hannifin air power cylinders, available in a full range of mounting styles, bore sizes from 1½" through 14", strokes to 20 feet. Cylinder bodies bored, then honed satin-smooth . . . for low friction, long packing life.

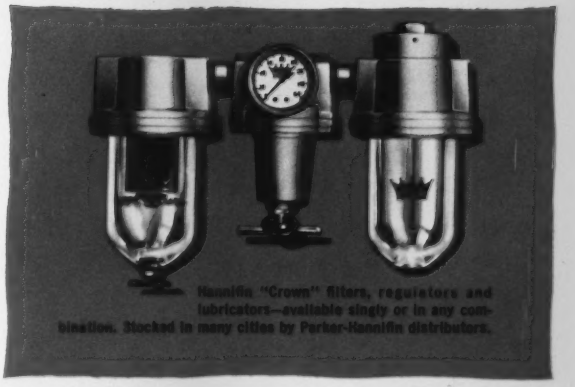
Hannifin's complete line of air control valves includes electric solenoid, pressure, cam, hand, and foot-actuated valves. Write for our complete 4-page "Valve Primer."

PARKER-HANNIFIN

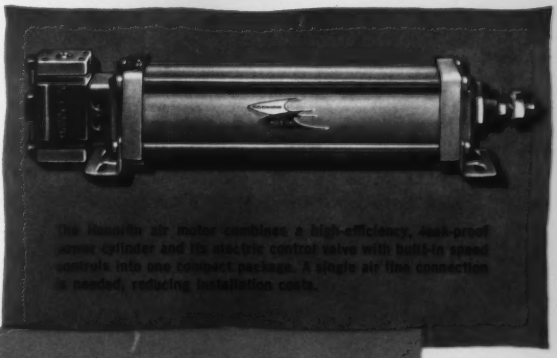
puts air to work without costly leaks

Now . . . complete pneumatic power systems, engineered for long leak-proof life, are available from your Parker-Hannifin man. Hannifin "Crown" units supply filtered, lubricated air at optimum pressure. Hannifin air valves shift quickly and seal bubble-tight. Hannifin air cylinders and air motors are low-friction, leak-proof. Parker "Push-lok" hose fittings and "Intru-lok" tube fittings provide quick, easy, leak-proof connections. The over-all result is more work from less air!

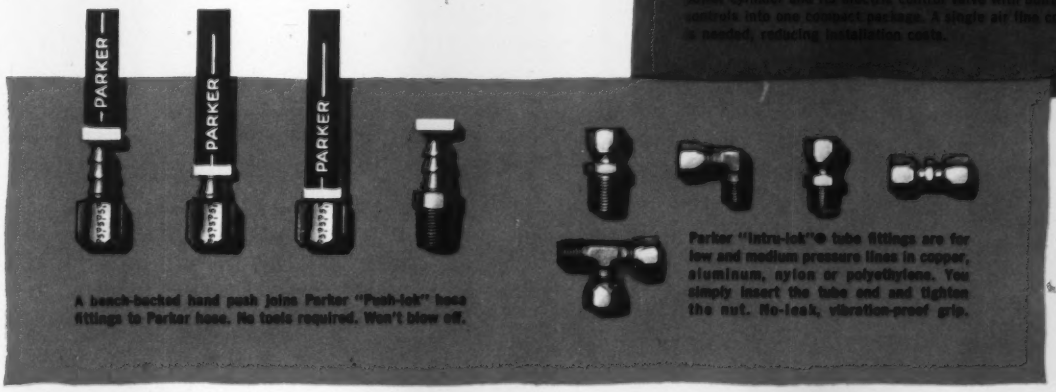
Our field engineering service helps you design your circuits and select the components. Many items are available locally, from Parker-Hannifin distributor stocks.



Hannifin "Crown" filters, regulators and lubricators—available singly or in any combination. Stocked in many cities by Parker-Hannifin distributors.



The Hannifin air motor combines a high-efficiency, leak-proof power cylinder and its electric control valve with built-in speed controls into one compact package. A single air line connection is needed, reducing installation costs.



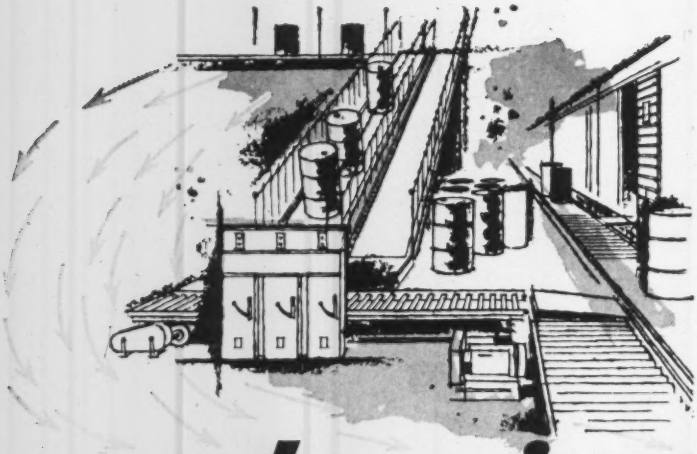
A bench-backed hand push joins Parker "Push-lok" hose fittings to Parker hose. No tools required. Won't blow off.

Parker "Intru-lok"® tube fittings are for low and medium pressure lines in copper, aluminum, nylon or polyethylene. You simply insert the tube end and tighten the nut. No-leak, vibration-proof grip.

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue, Cleveland 12, Ohio

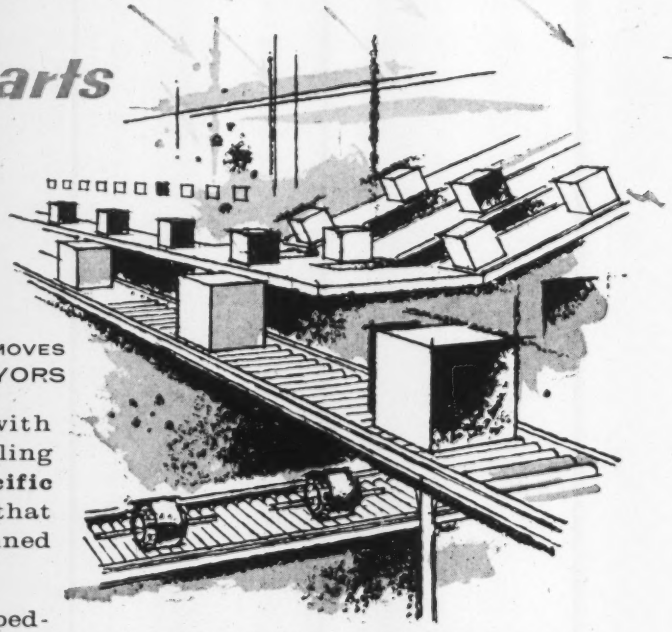
HANNIFIN COMPANY
555 S. Wolf Road, Des Plaines, Illinois

DIVISIONS OF PARKER-HANNIFIN CORPORATION



synchronized

movement of materials and parts



ANOTHER REASON WHY INDUSTRY MOVES
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The Hoover Co.	Borden Co.
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ALVEY

CONVEYOR MANUFACTURING COMPANY
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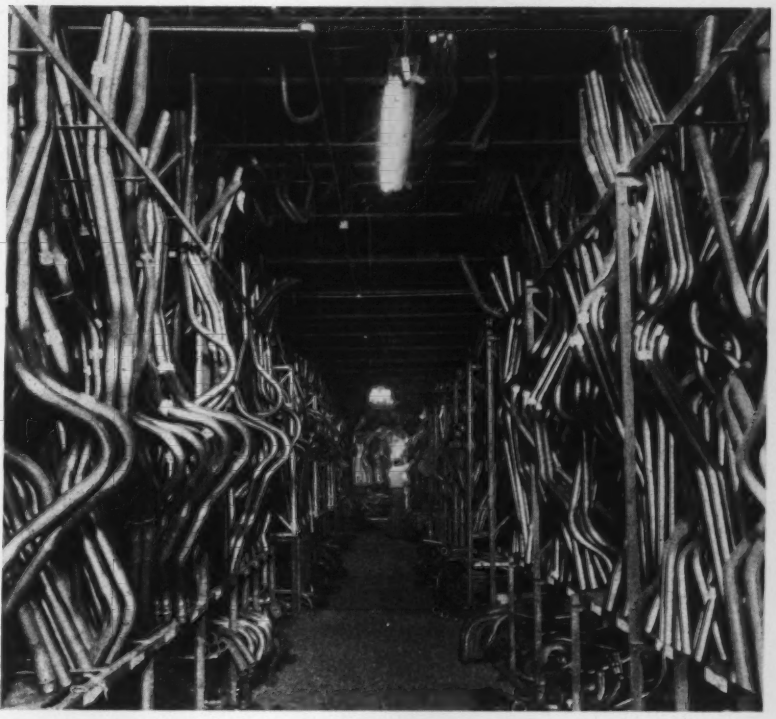
By JAMES C. KEEBLER Managing Editor



Concept of numerically controlled tailpipe bending machines for use by auto parts distributors reckons to straighten out the warehousing problem evident in this picture of a typical tailpipe warehouse.

Bending to Order

FOR AS MANY years as the automobile has been a part of the American scene, comedians have been warning the bachelor population that matrimony is just like automobile ownership: "It's not the cost, it's the upkeep you've got to look out for." Those of us who champion the finer things of life recommend that this admonition should not be used as a deterrent to acquisition in either case, even though some element of truth can be ascribed to this witticism.

The head of the household can usually give pointed testimony to support the premise that there is a lot of money being spent to keep the vehicles of the nation roadworthy.

Big Problem

One company that feels business growth comes as the result of forward planning is undertaking a program aimed at securing a larger share of this vast market. To do this the Nu-Era Corp. of Rochester, Mich., entered the highly competitive exhaust-system replacement field in 1956. Herbert Carson, director of special projects, reveals some figures that show the bigness of the market. Last year they counted between 700 and 750 different types of tailpipes on the market. In that year, for example, Ford added 22 new models to its line and Chevrolet added 21. The 1959 replacement market for exhaust systems totaled an estimated $360 million.

Phillip Chapnick, president of Nu-Era, tells how the company observed that the stocking of a great quantity and variety of tailpipes in distributors' warehouses had become an increasingly entangled problem. One of their customers devotes 25,000 square feet of warehouse to tailpipe inventory alone.

To help solve the problems inherent in this type of business Nu-Era decided on an entirely new approach. The idea is for the distributor to stock 16-foot lengths of straight tubing in the four basic diameters used for tailpipes, and do the bending to order as each of the specific model configurations is required.

Needed a Machine

To implement this idea it was necessary to develop a machine to do the bending to order. Chapnick pays high tribute to ". . . one of the true wonders of modern free enterprise . . . . Nu-Era, a relatively small company, had a big problem. We had an idea—a concept—nothing more. We had neither the technological know-how nor the facilities to turn the concept into fact.

"When we brought our problem to Baldwin-Lima-Hamilton, with their great experience in heavy manufacturing, they in turn sought the aid of General Electric in developing the intricate electronic control system required to operate the Bend-O-Matic. Soon it was obvious that our problems were in excellent hands, and the Bend-O-Matic began to take form and become a reality."

The form and reality of this machine enable the operator to produce tailpipes to order by selecting a piece of tubing of the proper diameter and putting it into the machine, selecting a proper punched tape and placing it into the tape reader, pressing a button and, less than two minutes later, removing a tailormade bent pipe from the machine.

The machine has a chucking arrangement mounted on a carriage. The travel of the carriage can feed the pipe lengthwise through a bending station. The rotation of the chuck can turn the pipe about the axis of the yet unbent length such that a successive bend may be achieved in a different plane than the preceding bend. This combination provides for compound curves

and skewed straight segments in the various patterns required for different models.

The bending station incorporates a selection of dies and bending shoes. The appropriate shoe is hydraulically held against the proper die and the entire shoe-carrier swings around the centerline of the stationary die through an arc sufficient to accomplish a prescribed bend.

After completion of one segment of the bending, the pipe is automatically fed out and rotated to position for the next bend. Since most tailpipes are less than 8 feet in length at least two can be made from the 16-foot stock used. A saw is built into the machine to cut off the first pipe before bending the second.

Punched Program

The cycle of the machine is programmed by punched tape (one inch wide—eight channel—generally about 18 inches long) read by a Friden tape reader to supply input signals to the GE numerical control system.

D. B. Schneider, manager of metalworking program control engineering at General Electric Specialty Control Dept., says this application of numerical positioning control was not only unique but also challenging; is the most unusual application they have worked on to date.

The control system integrates the three principle motions of the machine and 13 auxiliary functions. Schneider describes it as follows:

"For most machine tools a single type of servo drive is used on all motions. On the Bend-O-Matic there was a definite need for two types. D. C. motors could be used for the length feed and for the rotation of the pipe but a hydraulic drive was needed on the bending motion to give the needed torque in the small space allowable for the drive. The first motion (pipe feed) required a high positioning speed of 600 inches per minute. This is three times the top positioning speed of our normal machine tool motion. An accuracy of ±0.050-inch was required so care had to be taken to eliminate a large overshoot normally present with high speed positioning.

"The second motion (rotation of pipe) was fairly straightforward from a positioning standpoint. The interlocking to make it work properly and at the right time gave our designers a few anxious moments.

"The third motion (bending of pipe) really taxed our imagination. A high bending torque was needed, and our thoughts turned to hydraulics to keep the drive simple and to conserve space. Normally on a hydraulic drive for a machine tool we would recommend a proportionally controlled hydraulic servo valve, but the accuracy of the bend was not too critical (±1.8 degrees) so to keep the drive simple we utilized still another type servo, the two-speed type. This allows fast movement with slow-speed approach, and its performance is not dependent to a great extent on machine characteristics.

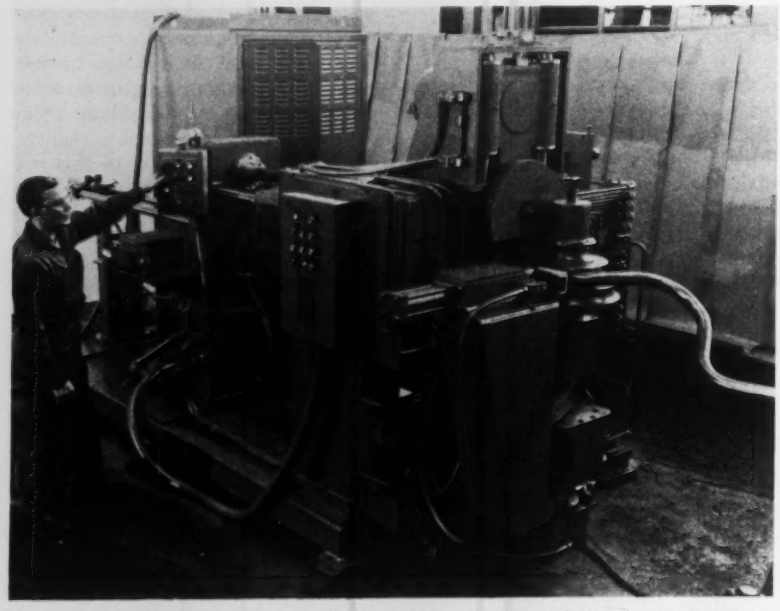
"Our best magnetic circuit engineer was called in to design the complex interlocking required by the clamping, flattening, and cutoff operations. . . . The data handling has been interwoven with the machine and control functions so no time delay will be experienced during the input of new information. While the machine is operating from previous instructions, new data is being stored for the next operation. Also, while one part of the machine is performing its function, another part is being reset and readied to take the next step."

Start the Trend

This development represents a step toward a concept of manufacture at the point of distribution which has been foretold by B-L-H Hamilton Div.'s Automation Consultant, Charles Hautau, who years ago predicted to technical society audiences that the future of industry was in small, mobile, highly automated manufacturing units that turned out merchandise virtually at the marketplace.

The total concept of making tailpipes at the distributor's warehouse involves flaring and other forming operations not incorporated in this machine, but these machinery problems are considered a small order of magnitude in comparison to the bender.

Nu-Era plans to lease the equipment and provide tapes for the user. To those timid souls who once considered electronics on the factory floor to be "Cloud 13", this venture must sound like a trip to the moon. However, all parties involved appear confident that distributor use of automated tailpipe benders is just around the corner.



Bent pipe is shown at exit end of Bend-O-Matic machine built for Nu-Era Corp. by the Hamilton Div. of Baldwin-Lima-Hamilton Corp. Machine is programmed by a punched tape numerical control system developed by the Metalworking Program Control Engineering section of General Electric's Specialty Control Dept.

Announcing

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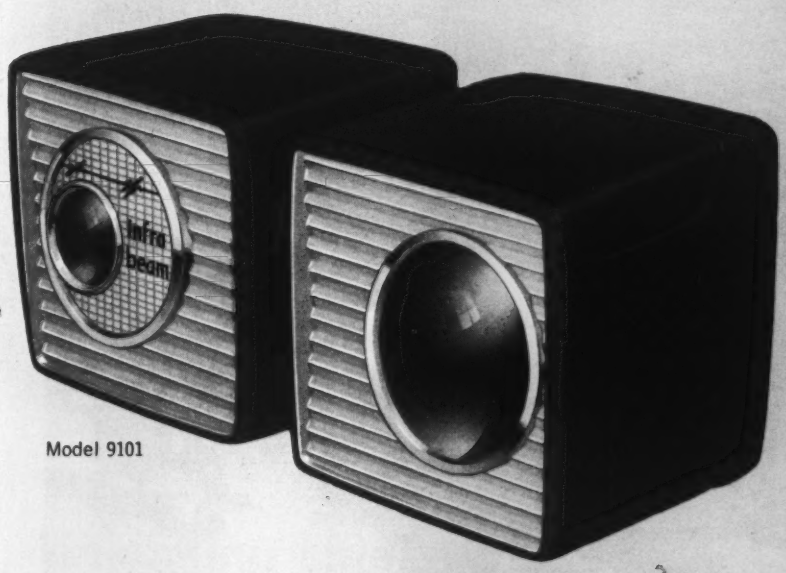
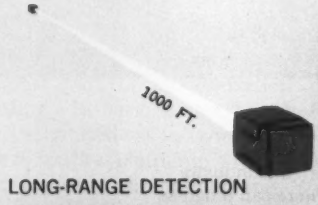
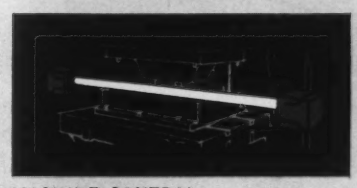


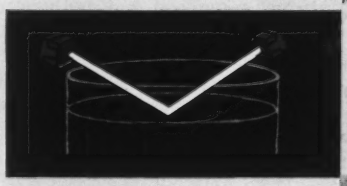
Model 9101



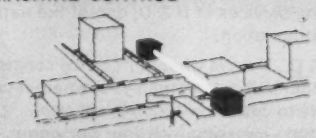
LONG-RANGE DETECTION



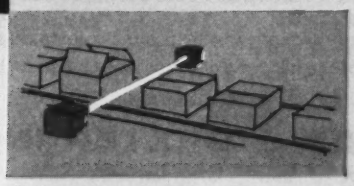
MACHINE CONTROL



LIQUID LEVEL CONTROL



INSPECTION OR SORTING



CONVEYOR CONTROL

FOR THE FIRST TIME, photoelectric control is *simple, reliable,* and *practical* over an extremely wide range of applications.

Infrabeam is a totally new type of photoelectric control . . . developed and tested over a period of more than a year, now ready to go to work in your plant or as part of equipment you manufacture. It offers a combination of simplicity, sensitiveness and reliability that has never before been achieved.

New infrared detectors, perfected for missile guidance, are in many ways superior to photocells that respond to visible or ultraviolet light. In Infrabeam, the Receiver contains a similar infrared detector which is screened against visible light by a simple optical filter. Further, the infrared beam from the Projector is "modulated" — brightening and dimming at a frequency of 400 cycles per second. The Receiver is electronically tuned to this frequency, so that the control will not respond unless it gets a signal from the associated Projector.

WHAT THIS MEANS TO YOU...

Compared with standard "general purpose" photoelectric controls, Infrabeam provides far greater sensitiveness in countless applications at close or moderate range. At extreme range — as much as 1000 feet — it offers superior reliability and freedom from interference. Because it operates equally well by reflecting the infrared beam from a detected object and into the Receiver, it is the *only* photoelectric control able to reach into "blind" areas with perfect freedom of installation.

Projector and Receiver are attractively housed in anodized cast aluminum. The quick-detach hinge allows easy separation for use as opposed units, or accurate angling for use in reflection. Physical mounting and electrical connections are simplicity itself, and permit quick replacement of either unit without disturbing permanent wiring.

Find out how simple and practical photoelectric control can be for *you*. WRITE TODAY FOR COMPLETE DETAILS AND SPECIFICATIONS.

ELECTRONICS DIVISION

CRAMER CONTROLS

CORPORATION

CENTERBROOK, CONNECTICUT

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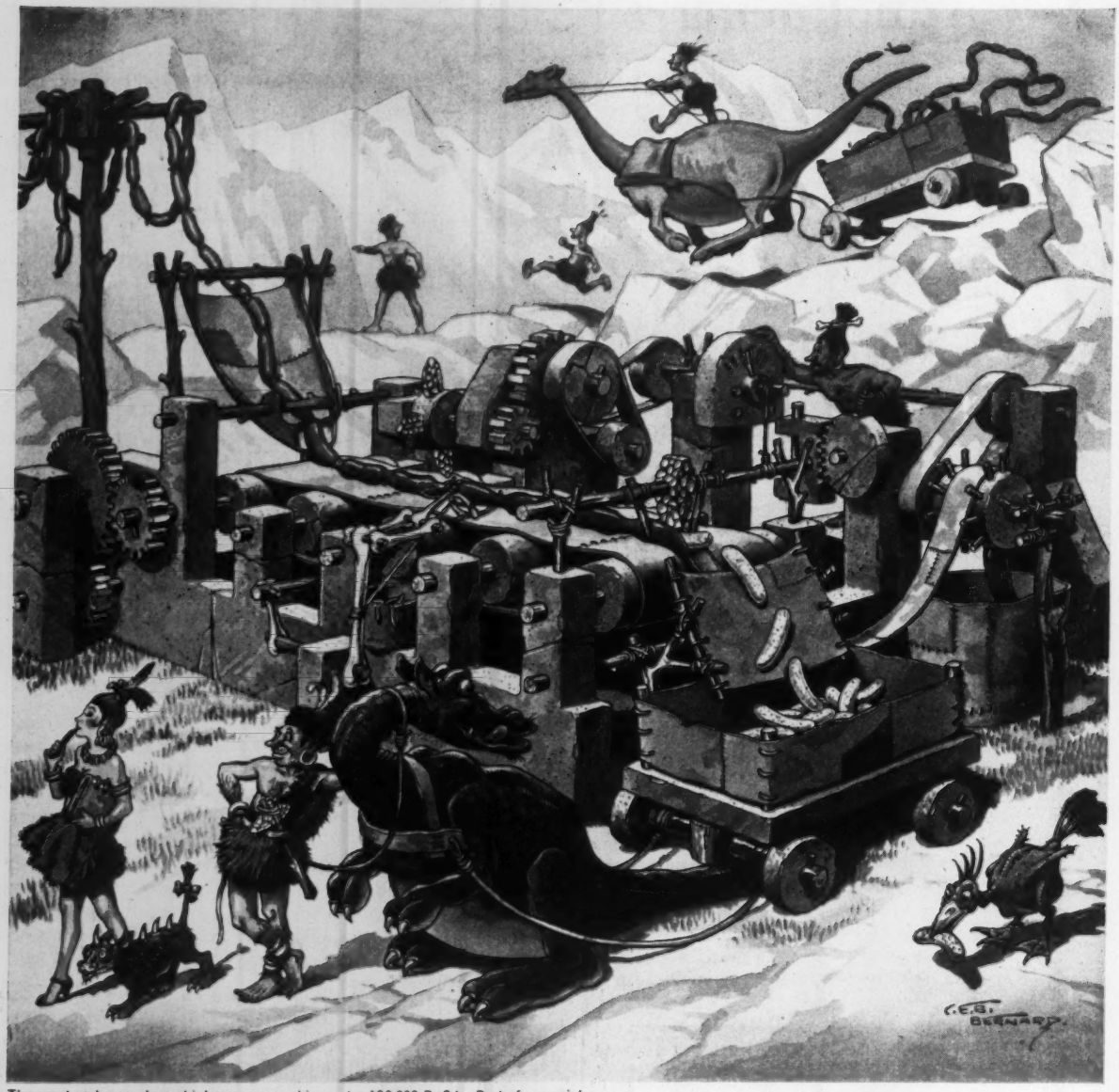

The great and marvelous skinless sausage skinner (ca 106,000 B. C.) Part of a special pictorial history of automation by Barkley & Dexter, Inc.

GREAT MACHINES OF WESTERN MAN

This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

You should know more about B & D. Here is what our service consists of:

PLANNING — we determine if mechanization can help you; where it can help you; how it can help you; how much it is likely to cost; how much it will save.

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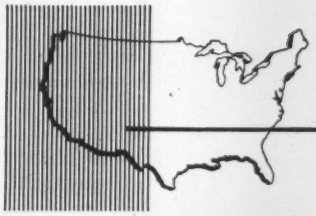
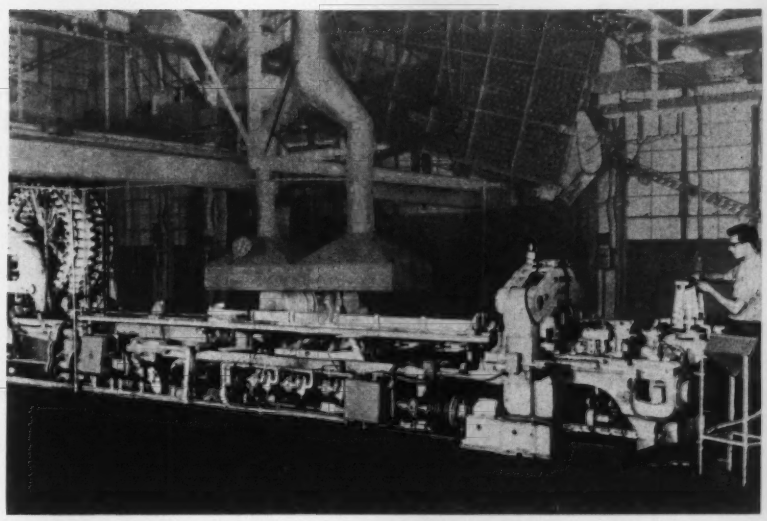
PROGRESS AND PROFIT . . . THROUGH MODERN AUTOMATION ENGINEERING

Circle 681 on Page 19



western trends

By PATT PATTERSON
Los Angeles, Calif.



HIGH-SPEED can line built by the Container Machinery Div., E. W. Bliss Co., produces a large variety of can sizes at speeds up to 450 units per minute. Only one operator and one maintenance man are required to handle the line. Can blanks are manually loaded into the bodymaker by the operator who also keeps a double seamer supplied with ends. The transfer of can bodies from the bodymaker through flanging, double seaming, and testing is accomplished automatically. This type of equipment is especially suitable to packers who need a variety of can sizes to handle many different products.

Unkinking Lines

AUTOMATION in the aircraft and missile industry is becoming an accepted part of modernization programs. In basic metals, automation is recognized as a vital factor in new facility planning. In associated industry throughout the West, automation has become a growing force.

But in one of the largest industries in the West, food raising and processing, automatic techniques are in their infancy. There are, of course, some areas where it has grown more rapidly than others. In the fields, where crops are planted, tended, and harvested, automation lags. In the processing plant, however, there are indications that automatic equipment and planning have become recognized.

One of the major areas is in packaging. This is an activity which lends itself quickly to automatic methods. Particularly where metal cans are used to protect the product, automation has made rapid strides. Many of the larger food processors have installed their own automated can lines to produce the packages they use in such large quantities.

Cost has been a major consideration. The cost of the container is often a prime factor in competitively pricing a product which has a small margin of profit. Automated can lines provide a competitive position with a large investment in capital equipment, but with little outlay in labor. In some plants, such as Hunts Foods, in Fullerton, Calif., an automated can line is located next door to the processing plant, and cans roll off the solder line to move directly to the canning line. The processor does not lose valuable processing space for can production, and there is no transportation involved in getting the cans from the manufacturing machines to the filling machines.

In addition to these larger processors who install their own can lines, the larger can makers, such as Continental Can, American Can, and others, have opened plants throughout the West, near the major food production centers. Transportation is a problem in shipping cans for long distances. Although empty cans and lids weigh relatively little, space is the drawback.

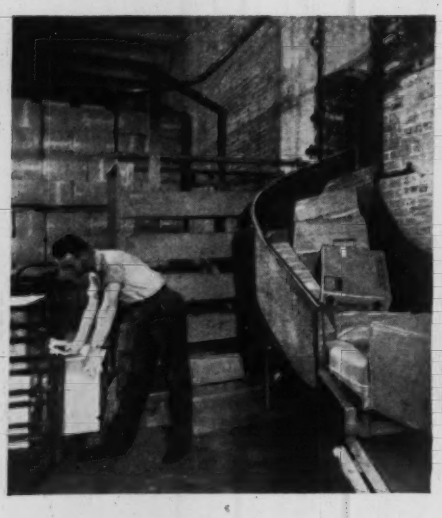
In addition to the makers of cans, there is one large can machinery manufacturer operating on the West Coast. This is the Food Machinery and Chemical Corp., with a major plant in Southern California.

Processing Printing Plates

At the West Covina, Calif., plant of Lithoplate Inc., a subsidiary of Harris Intertype Corp., presensitized lithographic plates are made by an automated system which is one of the first of its type in the industry.

A special etching and metal preparation line prepares the plates for their coating of presensitized emulsion. The line is a continuous conveyor system of an entirely new type. Manufactured for Lithoplate by Hanson-Van Winkle-Munning Co., the new conveyor automatically dips the racks of plates into a series of metal treatment and rinse tanks, according to a preselected program.

The racks are manually loaded on the conveyor, and then the process is completely automatic until the time the plates pass into the emulsion coating process. The conveyor carries the racks over a double line of tanks. At predetermined times, the racks are lowered into the tanks, raised again, drained, and moved to the next position.



W. E. PULLIAM, plant superintendent for the Tayloe Paper Company, points out: "The Standard spiral chute and pneumatic tube system paid for itself within the first year, just in operating savings alone."

"It used to take us from 30 to 45 minutes to fill a 'customer-wait' order, but

NOW we handle 'em in 5 minutes... we've saved $30,000, too!"

In five years the Tayloe Paper Company has realized savings of $30,000, thanks to its Standard spiral chute and pneumatic tube conveying system. And each month the Memphis, Tenn., firm continues to show savings of at least $555.

The Standard installation has been building customer good will, too. It used to take Tayloe Paper anywhere from 30 to 45 minutes to fill a "wait" order. But not anymore. Standard's tube-chute system delivers the goods in 5 minutes.

Economy is a day-to-day reality at Tayloe. Previously, a man worked full time on a slow-moving freight elevator delivering orders (the Standard spiral chute now conveys an order in 8 seconds from the top floor — the 5th — to the first floor shipping department). There's no order runner either (the Standard pneumatic tube system "runs" orders in practically nothing flat).

Standard engineering was vital in assisting Tayloe Paper streamline its shipping department. It cut the need for space-hungry 4-wheel trucks by 30%.

Standard is qualified by experience to engineer a materials handling system to cut *your* costs. Write: STANDARD CONVEYOR COMPANY. General Offices: North St. Paul 9, Minnesota.

Send for Bulletin No. 309
Address Dept. EE-3

Sales and Service in Principal Cities

The critical presensitizing process requires a properly prepared metal plate to serve as an emulsion base. With previous manual methods, rejects were high, and final inspection scrapped a large number of plates because of imperfect coatings. With the automatic line, however, quality has improved, and the finish of the plates reaching the emulsion coating station is well within the narrow limits of tolerance imposed by the process.

Processing Logs

At Weyerhaeuser Company's new sulfite pulp mill at Cosmopolis, Wash., bulk materials handling has speeded paper pulp making. The mill requires about 395,000 board feet of logs daily for the continuous pulping process which produces some 400 tons of pulp.

Logs are cut in 24-foot lengths for ring barking, or in 42-foot lengths for hydraulic debarking. The logs are automatically carried from the barkers to chippers by a chain and spur arrangement which is automatic. One of the largest chippers in the world, a 175-inch, 6-knife unit, reduces logs up to 40 inches in diameter to chips for the pulp digesting process.

Drag chain conveyors carry the chips from the chipping pits to a surge bin. A chain drag beneath the bin transfers the chips to a belt conveyor which moves them up an incline to a screening house above storage silos. The chips are graded on double-deck vibrating screens which discharge into six silos.

Chips are stored in the silos until required for the pulping process. They are taken out by 17-foot diameter rotary table feeders. The tables revolve under each silo and carry the chips from storage to belt conveyors which transport the chips to the cookers. The chips travel over three belts, which move them 300 feet from the silo area, and then lift them up a 12-degree incline for 420 feet, until they are at the top of the digester building.

The chips are weighed by a belt scale before they are automatically diverted by a remote-controlled tripper to any of seven digester charging ports. Batch weights are recorded in a cook room control center where instrumentation indicates when a 90-ton digester load is required.

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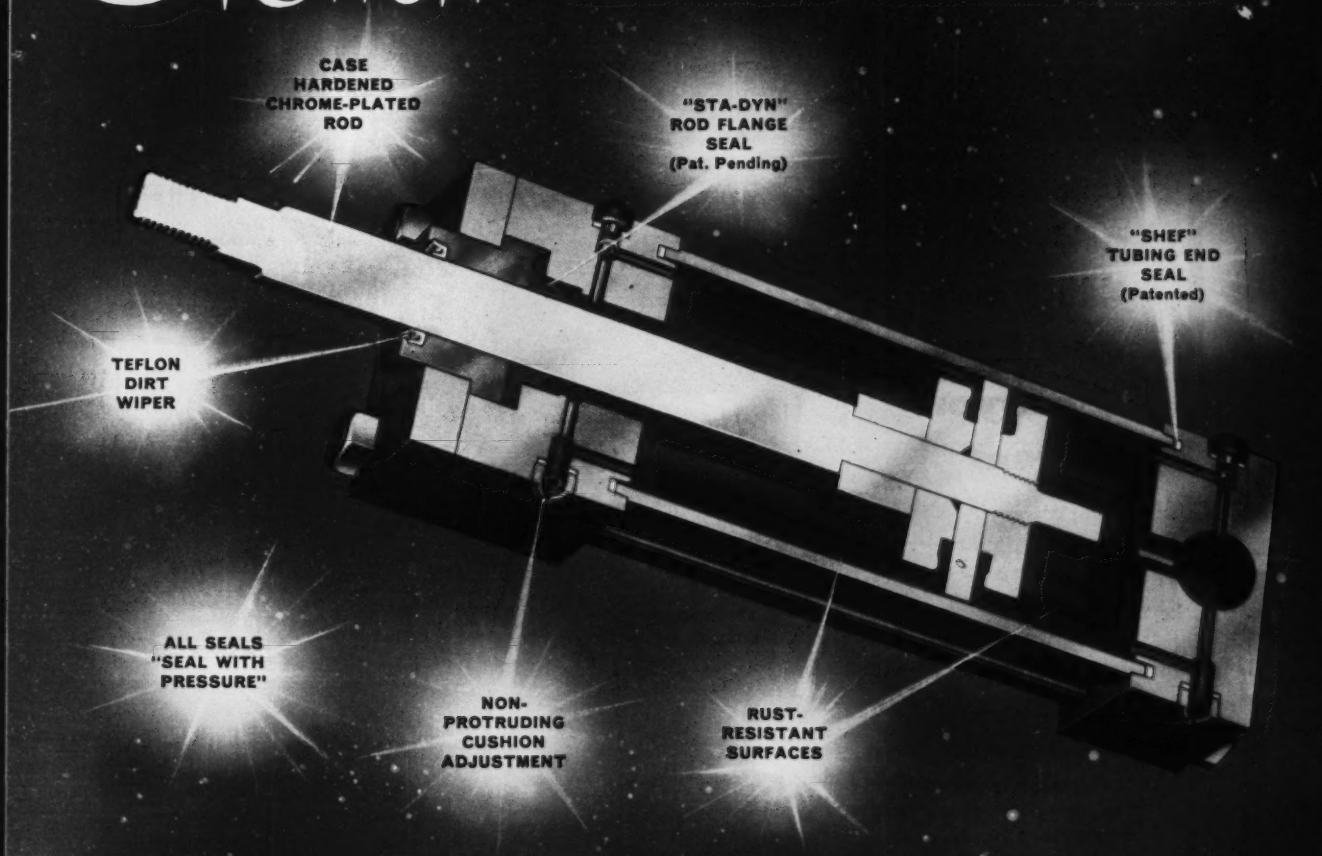
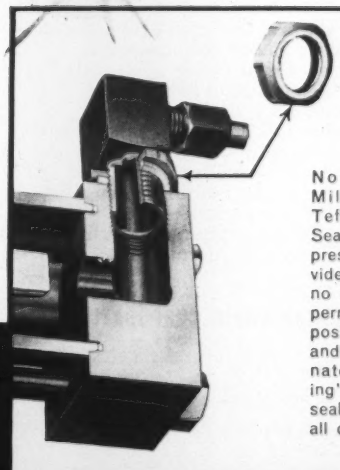
Stellar RELIABILITY and ECONOMY


CASE HARDENED CHROME-PLATED ROD
"STA-DYN" ROD FLANGE SEAL (Pat. Pending)
"SHEF" TUBING END SEAL (Patented)
TEFLON DIRT WIPER
ALL SEALS "SEAL WITH PRESSURE"
NON-PROTRUDING CUSHION ADJUSTMENT
RUST-RESISTANT SURFACES

Miller AIR CYLINDERS

PORT SEALS



Now—with every Miller Cylinder—Teflon-sealed Port Seals that "Seal with pressure" are provided as standard at no extra cost. They permit much faster positioning of lines and fittings, eliminate "overtightening" damage, and seal perfectly against all operating media.

Here are eight more reasons why Miller Air Cylinders continue to be the most economical and reliable cylinders that money can buy. These stellar features—including the new port seals—are standard Miller construction—yours at no extra cost. Thus, they provide appreciable savings in original investment—*particularly for those who insist on "J. I. C." quality throughout.* Savings in operating costs are even greater, because these features are proven assurance of longer cylinder life, greater efficiency, reduced maintenance and downtime.

Specify "Miller" for greater reliability and economy! Write for bulletin.

MILLER FLUID POWER

7N026 YORK ROAD, BENSENVILLE, ILLINOIS

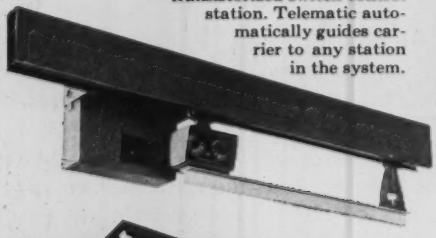
Power-Flex

the new proved* CM Power and Free conveyor system

View shows major components of a Power-Flex installation and indicates a few of the many power and free rail configurations possible with this system.

*Names and locations of installations on request.

...equipped with Telematic dispatch control Illustration below shows trolley mounted Telematic route selector dispatch head and transistorized switch control station. Telematic automatically guides carrier to any station in the system.



Power-Flex construction and operating features include:

- **RAILS** roll formed of high tensile strength corrosion resistant steel.
- **SWITCHES** are manual or fast acting electric; have curve radii maintained through switch.
- **POWER CHAIN** is carburized, heat treated high strength "CM" welded link design.
- **CURVES** are factory formed to close tolerance and heat treated.

Power-Flex maintenance is facilitated by inspection sections in the rails.

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Computers

Few aspects of automation have been subject to as much discussion, publicity, and confusion as have computers. Like any other phase of automation technology, however, a long period of research, experimentation, and pilot study application has clearly defined the general areas of practical use for the future.

Because processing of administrative data vital to the over-all enterprise is so closely associated with production operating data in the plant, computer applications have developed in both areas. Office data processing has been most actively developed but the obvious need for direct tie-in with plant operations is becoming much better recognized. Today, active experimentation in computer control of equipment is in progress—chemicals, petroleum, steel, and power generation. Here integration of data and control reaches its highest level.

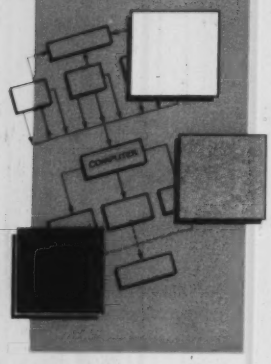
The time is ripe to take a realistic look at computers, data processing, and control as they stand today. A general roundup article, beginning overpage, offers an over-all review of the present status. How the various system stages compare and fit together is shown graphically to simplify understanding and aid application study.

The particular need and obligation was effectively highlighted by E. A. Clarke of Humble Oil at the Winter Meeting of AIEE in his statement, ". . . there exists a large gap between the petroleum engineers who need the computers and the electrical engineers who design and build them. As the computer engineer cannot be expected to become an expert in the oil business, there remains only for the petroleum industry engineer to learn computers if this gap is to be bridged." This is true not only for engineering computation but also for computer application in any phase of the plant operation.

General knowledge and use of computer techniques has grown through a long series of evolutionary stages. Present applications in manufacturing operations indicate the steps toward integrated control will follow a like pattern. Gradually, development will grow from general handling of office data and central digesting of plant data to over-all automatically co-ordinated plant control wherever need and economics dictate.

EDITOR

AUTOMATION



ROLE OF COMPUTERS IN AUTOMATION

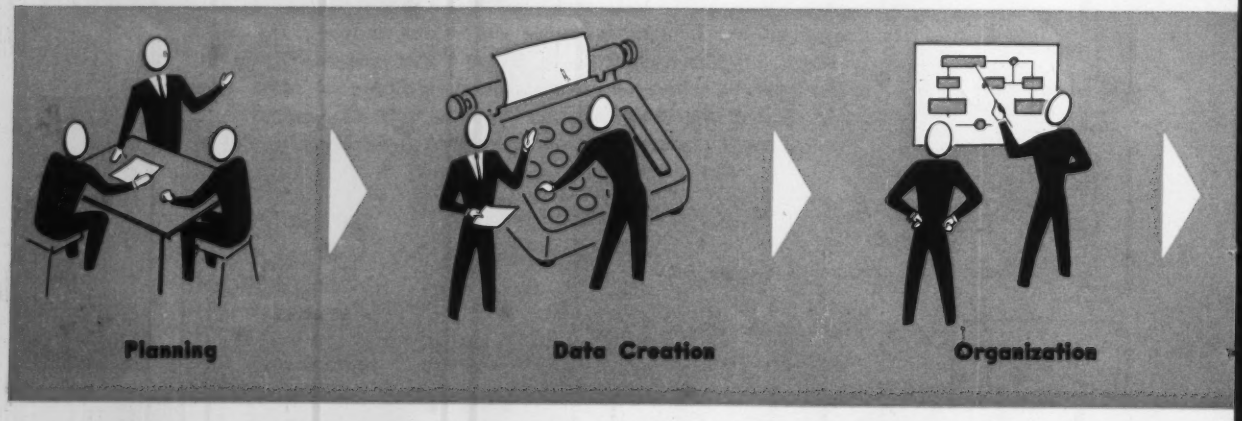
By J. H. McRAINEY, Associate Editor

A STUDY of the technology of the last 10 years leaves little reason to doubt that the 1960's will see computers achieve a notable place in our society. With modern man's propensity to apply tools whenever progress can be served, the role of a tool is assured when that tool aids in the solution of so universal a problem as obtaining effective data handling. For data handling is the basis of accounting, payroll, production control—indeed, all administrative operations—the mathematical analyses of processes and designs, information logging operations, and all control systems. For the purposes of this article on the application of computers, these uses have been grouped into the general areas of scientific, control, and administrative data processing.

Though evolutionary in the sense that it has proceeded in an identifiable step-by-step manner, the progress of computer technology exhibits many of the characteristics of a revolutionary innovation because of the speed with which developments have occurred and have been placed into use. This quasi-revolutionary aspect of practical computer technology, with the inherent confusion that attends any revolution, is heightened by what appears to be a true revolution in basic concepts concerning communications in general. The rigorous treatment of information demanded by computer technology has assisted in the formulation of new ideas concerning the transmission and receipt of messages, or communications, in all types of systems—physical, social, electrical, etc.

As if the uninitiated were not confronted with a big enough factual problem in attempting to follow a rapidly developing, and seemingly revolutionary technology, experts compound the task by introduc-

Elements of Effective Data Handling



The importance of invention cannot be minimized, but significant progress follows primarily from the widespread application of a new technique. And that time appears to have come for the computer. The underlying need for greater efficiency in control and administration has always been present. The ability of computers to answer this need has been proved in a wide variety of applications.

ing the matter of semantics in not agreeing as just what constitutes a "computer." All computers do not compute in the dictionary sense of the word, nor are all devices that compute called "computers." Thus it is that "computers" are associated with such varied tasks as solving mathematical problems, expanding parts lists, keeping inventories, translating languages, simulating battles, and controlling processes, to name but a few. Yet on the other hand there are devices that add, subtract, integrate, etc., to which the term "computer" is considered to be a misnomer.

But however confused the general picture, the application of computers in the industrial areas of control and data processing has resulted in practical systems that are as significant for what they promise as for what they achieve.

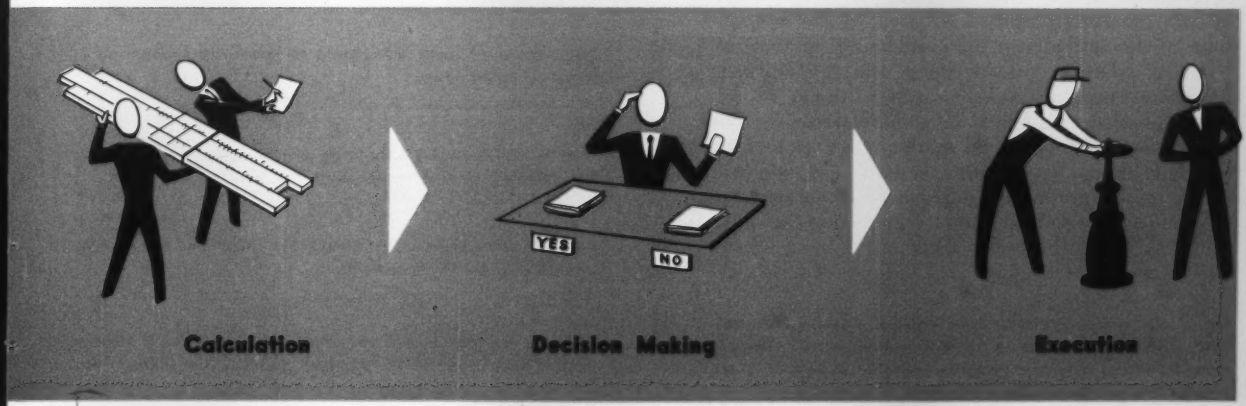
A Basis For Review

In reviewing the general subject of computers it is useful to begin with a consideration of the elements of effective data handling, *Fig.* 1. Typically, effective data handling will involve the following points:

Planning. A general scheme or procedural guide covering a specific situation must be prepared (identification of goals, statement of problem, selection of events or variables that apply to problem, how to handle details, etc.). In this all important initial stage in which procedure is determined, problems that can be completely defined by equations contain the guides as to the procedure to be applied (this is not to say that implementation will necessarily be easy). In contrast, there are elaborate data processing tasks that can require several years of preparation and study accompanied by extensive revamping of paperwork flow and data collection techniques before an acceptable procedure is established.

Data Creation. Pertinent data must be created or obtained (by reading dials, making measurements or analyses, searching through files, observing events, etc.). For control applications, data creation embraces all of the instrumentation techniques for measuring and analyzing; in general, the prob-

Fig. 1—The major elements of effective data handling are shown. The indicated functional elements are performed by either humans or machines when any quantity of data must be handled for the solution of a problem.



lem is simple or complex depending on the quantity to be measured, the process, and space-time factors. For business systems, data creation follows day-to-day transactions; here the problem is simple or complex depending on the quantity of transactions, location of reporting sources, and the extent to which accuracy of reporting can be controlled. An almost universal problem in the data creation phase is the reduction of the time lag that separates the occurrence of some event and consideration by the system of data representing the event. Reducing this time lag is usually obtained at the expense of introducing additional complicating factors into the picture.

Organization. Data must be organized in some manner that will facilitate calculations or further use (display, rearrange, encode, decode, simplify, round-off, etc.). The organization of data overlaps into the functional elements of data creation and calculation, and the form that organization takes is also influenced by whatever general procedure has been established. Organization primarily stands as a separate functional element in effective data handling to emphasize the fact that data cannot always be processed efficiently in the random manner or exact form in which it might be created. The emphasis or organization of data in any system is related to the time requirements of the system and to the quantity of data handled. Some data might be more important or critical than other data to efficient and safe operations. When this condition is present, the organization is complicated by the requirement that the critical data be identified as soon as it enters the system. That even the simplest form of organization can be important is evidenced by the readiness with which process industries have adopted graphic panel displays of indicating and recording instruments.

Calculation. A typical requirement is the performance of calculations or data manipulation, and the organization of the results of such operations (compare, add, subtract, multiply, divide, integrate, differentiate, etc.). The complexity of calculations in data handling problems is based on the relationships of the variables in the problem, or, more properly, on what is known about the relationships. Requirements vary between such extremes as scientific problems on one hand—characterized by the application of sophisticated mathematical techniques to relatively small quantities of data—and administrative problems on the other hand—characterized by the application of simple mathematical techniques to relatively large quantities of data.

Here it should be emphasized that this element of effective data handling rests upon the ability to identify the logical pattern that expresses the relationship of things, both physical and abstract, and the ability to represent those things in a "language" form. Tools that have been devised to "calculate" are based on the identified logical relationships and the ability of the tools to deal in a certain language form. Thus it is that a given tool can be of help in any problem that can be fitted to the logical pattern which underlies the design of the tool and that can be expressed in the language form in which the tool deals.

Decision. One of the more critical elements involves evaluation of the results of calculations and formulation of a decision on the basis of the evaluated data along with any other qualifying factors which are known to apply. Here the problem is one of discriminating between mathematically or logically correct data and incorrect data, and also the separation of the correct data into either a meaningful or meaningless category. With the assurance of correct, meaningful data the results of calculations can form the basis for a decision if—and it is an important if—all of the factors that bear upon the

Planning

Advanced control system in which computer performs necessary calculations and automatically readjusts set points of controllers.

Advanced logging system in which computer is used in data reduction operations and to prepare suggested operator instructions.

Sophisticated data collection system that organizes data for subsequent use. Minor calculations sometimes performed by equipment.

Application of modern techniques to those situations in which straightforward data handling represents major part of business; operation is highly refined.

Highly integrated application of modern techniques to system that embraces all major departments in a business.

Application of basic equipment to speed up processing of data in limited areas.

Use of sophisticated computing machine to solve problems too difficult or time consuming for simpler equipment.

Creation of specialized, small scale automatic systems by linking devices as necessary.

Isolated application of automatic devices which include computational element; typically applied for limited end.

Fig. 2—Diagram indicates how various systems compare with each other relative to the elements of effective data handling. The bar graphs represent extent to which equipment performs the indicated function.

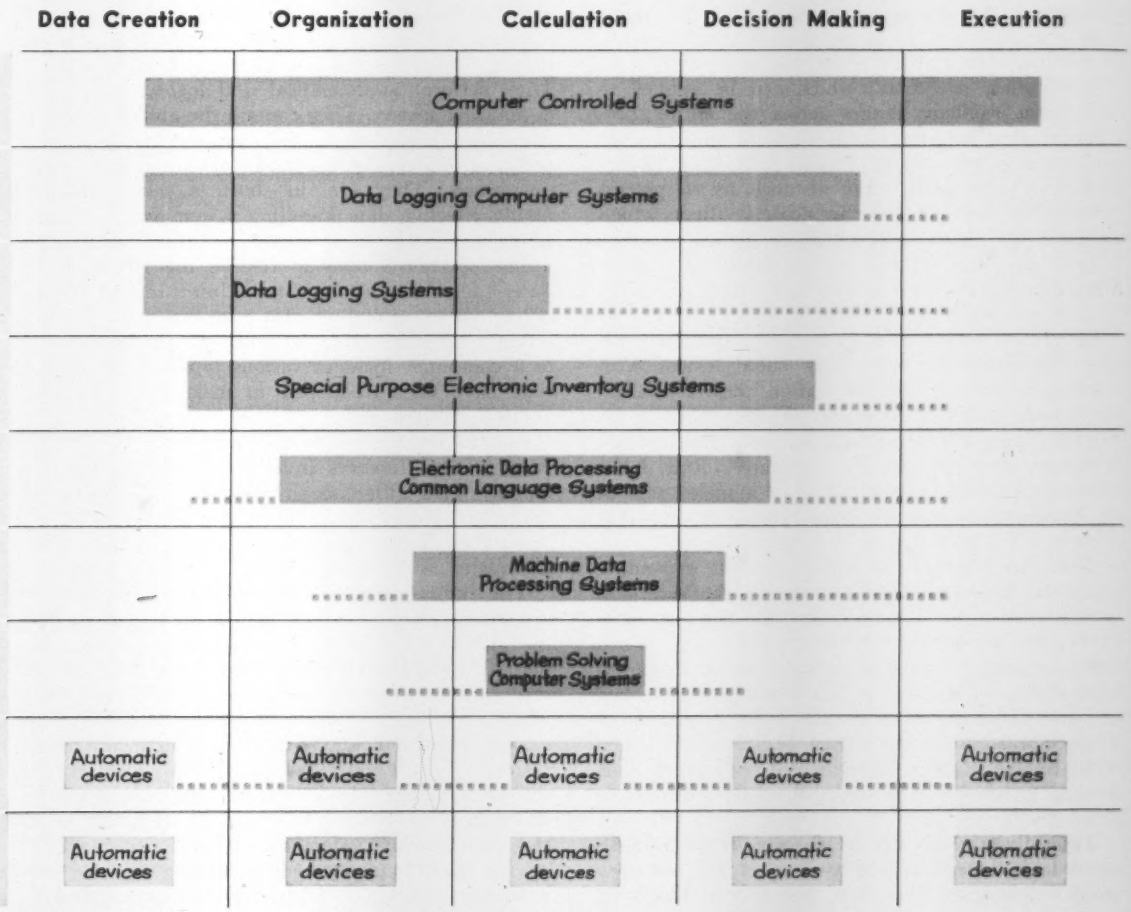
decision have been included in the basic data. Unfortunately, few processes involving many variables are so well understood that a decision automatically follows from the assimilation of data. When systems are not or cannot be understood in the mathematical sense, an automatic decision can only be obtained by introducing safety factors or allowances for the unknown—a workable but inefficient approach used in solving many problems. The more typical approach to the problem of decision making is to rely upon the judgment of an experienced person to compensate for the vagaries in a data handling system.

Execution. The final element in effective data handling is execution of the decision, which implies not only doing something but also following through or checking to verify that the effects obtained were those anticipated. Provisions for automatic follow-through, or feedback, are particularly critical to effective data handling as the time element during which changes occur or can occur becomes shorter. In other cases, automatic follow-through is essentially a refinement that increases the efficiency of the data handling system.

The presence of the six fuctional elements of effective data processing might not be obvious in all applications, but in the solution of a problem involving a quantity of data, the elements will be represented by the actions of either machines or operators. According to the nature of a problem, however, there can be significant variations in the complexities of these elements and certain ones will be emphasized relative to others.

A Complex Field

There is a sustained interest in data processing equipment. This is understandable when it is considered that the flow of data takes place in all companies, that it occurs in a myriad of both isolated and interconnected subsystems, and that each company has many characteristics that create unique problems. Supplying equipment to this market is not a simple and straightforward matter. However, in this age of automation, many manufacturers have entered the field by developing techniques, elements, components, equipment, and systems that can be applied to data handling problems. Depending on each company's analysis of the market relative to their capabilities, the items offered might be either general purpose or special purpose in application;



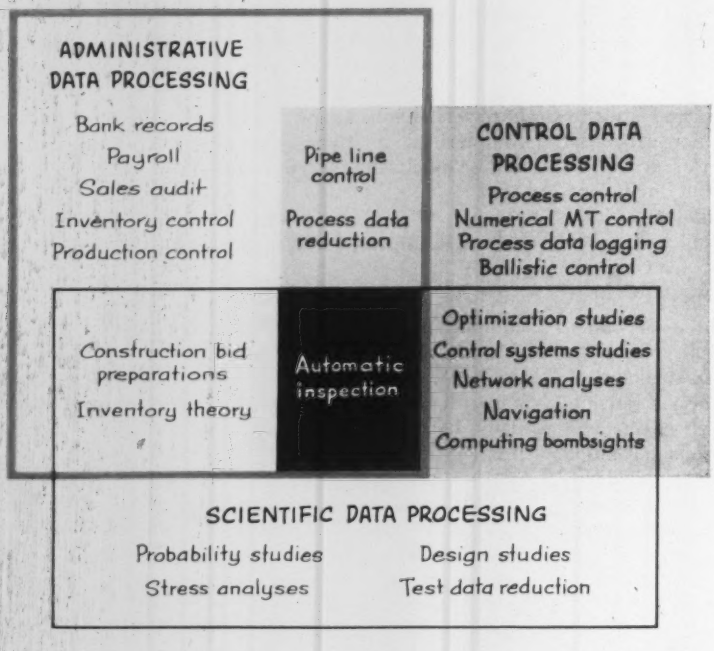


Fig. 3—These are some of the various applications in which computers have proved themselves. The overlapping of the three general use areas (scientific, control, and administrative) is an indication of the systems nature of data handling.

the items might be based on digital, analog, or combination analog-digital techniques; and the items might be described as being primarily mechanical, pneumatic, electrical, or electronic, etc.

The variety of "tools" which can be applied to help solve problems ranges across the entire spectrum of data handling, and many of the tools include means whereby automatic calculation is performed in some degree. For instance, in the process instrumentation field there are accessory items which compute the square root of input signals to allow linear indication of flow as measured by venturi tubes and similar devices. Logically, they are called "square root computers."

Relatively sophisticated automatic systems have been developed by combining such devices with automatic handling and actuation means. Herein lies a basic source of confusion about computers, for to most people if something performs calculations, it can properly be called a computer. And if the calculating device appears to play a major role in an automatic system, it seems proper to say that there exists a computer controlled system.

There is, however, an articulate and expanding group of technical specialists who take exception to this use of the word. Essentially their stand is that data processing becomes complicated when fast processing of data is required, when the interrelationship of data is difficult to visualize, when extreme quantities of data are to be processed, or when consistent accuracies are indicated. A somewhat related class of sophisticated tools have been devised to handle these complicated data processing problems.

Typically, though not necessarily, these sophisticated tools depend primarily on electrical and electronic techniques for their operation. They are either general purpose or special purpose, depending on whether they can be programmed to handle a variety of problems or whether they have a fixed program to solve only a given kind of problem. They perform mathematical and logical operations at amazing speeds. They contain the ability to direct their own activities within the confines of their program. They can be made to check their own operations. They are, in short, a self contained highly effective data handling system within themselves.

The specialists tend to reserve the word "computer" for this class of tools. Unfortunately in familiar usage specialists also use the word to describe what is in reality a system which, in addition to a computer, includes various types of equipment that have been developed to make the computer a more efficient tool.

Apparently, then, misunderstanding is created because of differences involving "degree" and not "kind." This difference in degree is illustrated in *Fig.* 2 in which major application classes of automatic data handling systems involving calculations are related to the elements of effective data handling.

The horizontal bars cutting across vertical lines separating elements show that systems provide for the indicated functions in a highly integrated manner. The different amount that some bars extend into certain of the areas suggests the relative degree to which such functions are provided for. The dashed lines indicate that even though the basic system is not usually thought of as providing for the function, the nature of some subproblems allows the system to perform in a limited way similar to the most highly automatic system. For instance, as the chart indicates, data logging systems are primarily concerned with the functions of data

creation and organization, and to a lesser degree with calculations. Data logging systems can, however, contain provisions for automatically shutting down or isolating certain elements in a system in the event of trouble—operations that extend into the realms of decision making and execution.

Scientific Applications

As a simplification, the various application classes shown in *Fig.* 2 can be considered as examples taken from three major use areas for computers: Scientific, control, and administrative data processing. Close investigation will indicate that the three use areas are not rigid divisions, rather they overlap as illustrated in *Fig.* 3.

Historically, the computer evolved as a tool to aid in the solution of complex scientific and engineering problems—and the nature of a computer as a tool is most apparent in the scientific use area. Albeit an amazing piece of equipment, the computer is essentially an exaggerated slide rule or desk calculating machine, and it is used as such by the scientist. This is a fundamental point in reaching an appreciation of computers because it should be understood that a computer is no more capable of independently reaching the analytical solution to a problem than is a slide rule or calculating machine.

However, given a real or supposed analytical solution, the computer becomes a most powerful tool in determining a numerical solution. And once having been set up or programmed to handle a specific problem, the speed of computation available with an electronic computer makes it possible to explore the individual effects of the several variables by introducing new numerical values and resolving the basic problem.

A variation of this approach can be of use in establishing a mathematical model—a sort of analytical solution—for a physical process. Here a crude expression of the relations of variables is continually refined by investigating the effects of different numerical values and new expressions until the numerical solution consistently agrees with effects that can actually be measured on the process.

However applied by the scientist-user, the computer is a superior calculating device that dumbly awaits his pleasure; an extension of other forms of calculating devices the computer is used in scientific applications only when other tools cannot do the job. The alternative to using a computer in solving some scientific problems is to obtain no solution at all since calculating by other means is literally measured in man-centuries of effort. In such situations, justification for the use of a computer cannot be established in the usual manner.

If a solution is desired, the practical choices are between obtaining a computer or sharing the use of one through a co-operative arrangement or a computer center that leases spot time. If one is to be obtained, the economic problem appears to be one of minimizing the cost and maximizing the utility of the equipment. This requires an analysis of the types of projects handled or likely to be handled and a determination of how a computer can help, what type is best, and size required. The estimated volume of projects will allow some estimation of the hours the computer will be operated, and whether or not a special staff will be required (as opposed to having individual scientists and engineers do their own programming, etc.).

Insofar as capability and economic factors are concerned, there is a remarkably wide range of equipment from which to choose. The broad picture of scientific uses of computers might include scenes in which there is a typical good-natured bickering as to competing merits of various types of equipment, but there has been no evidence of any serious misunderstanding as to the proper role of computers and how they should be used in scientific programs.

The brief consideration of scientific data processing—in which specialists with special problems turn to special tools—can serve as a springboard for a discussion of practical industrial uses of computers because, as it has been pointed out, scientific uses overlap into both administrative and control data processing.

Control Applications

Indeed, the picture of the overlapping between scientific and control applications emphasizes one of the outstanding attributes of some computers that assures their future growth in industrial control uses. It appears that, with but few exceptions, the dynamic nature of modern large scale processes is not completely understood in the mathematical sense. Control concepts presently in use are built upon a base of empirical knowledge. And not only are the precise dynamic relationships of all variables not known, the analytical procedures for varifying quality and content of the results of the process are based on time consuming laboratory techniques that permit significant amounts of off-quality products to be produced before detection.

Considering the noteworthy control successes that have been obtained with only empirical knowledge and environmental instruments, it is possible to appreciate the great interest of the process industries in computers. In short, it is realized that one of the main problems facing the process industries is scientific in nature (relationships must be visualized, and concepts created and verified). It has been found to be feasible to connect a computer with a process such that the computer aids in the collection of data, with the long run aim of establishing a suitable mathematical model or of obtaining the basis for an analytical solution. Simultaneously with information logging, a computer can contribute to short-run goals by manipulating data in accordance with the best available knowledge and present suggested operating guides to an operator. The feasibility of this sort of application stems from the inherent inefficiencies in a completely manually con-

trolled process, and from the money value of throughput resulting from even a small increase in operating efficiencies which a computer guided operator system would be expected to realize.

This is an extremely sound approach to investigating computers. For example, it ensures that a computer matches its requirement; and also elements required during the investigating period will not be scrapped if a computer is not feasible since they will support lesser automatic forms of control.

This leads to the question: Will not the use of a computer always be indicated? The answer is no. The main criteria in evaluating a computer is concerned with the stability of the process in the face of changes outside the sphere of control of the system. For example, what happens in a process as ambient conditions are varied? As heat transfer coefficients change with tube fouling? As a slightly different specification of raw material is used? As a throughput significantly different from the optimum amount is scheduled?

If the process is sensitive to a variety of these types of changes—and if they occur with any frequency—then the consistent efficiency which can be obtained with an operator is limited. If, on the other hand, a highly stable process is to be controlled, then the various forms of manually-adjusted set-point controls are quite satisfactory. It is apparent that if all processes were analyzed, you would expect to find both subsystems and systems ranging from the extremely stable to the extremely unstable. Those systems or subsystems suitable for computer control applications can be ascertained only by study. And the type of computer and the specific form that type should take can be ascertained only by study. In its proper perspective then, the feasibility study is really an investigation of a process to determine if its control scheme can be updated to advantage in view of modern developments—whatever form the developments take.

Here is a typical approach in investigating the desirability of computer control (as suggested by the Instruments Div., Beckman Instruments Inc.):

1. Feasibility Study. In a joint feasibility study the process is analyzed in relation to its effectiveness in attaining anticipated goals . . . a study may uncover the need for some immediate refinements of process technique to increase efficiency . . .

2. Instrumentation. If it appears that a computer will contribute to . . . process control, the next step is to install proper conventional and analytical instrumentation . . . Improved instrumentation will probably make an immediate contribution to process efficiency . . .

3. Data Collection. Collecting and arranging data is a necessary prerequisite to selecting and programming a computer . . . will log all data and perform preliminary off-normal evaluations . . . will give plant operators a centralized source of information for day-to-day manual control.

4. Selecting the Computer. Use of operating data . . . simplifies selection of the computer . . . The actual computer finally selected may be any one or a combination of several types, i.e., a general purpose digital, or a special purpose digital or analog computer. An analysis may even indicate the best process control results will be obtained by using a number of conventional pneumatic or electrical analog control instruments.

5. Adding the computer to the control system . . . will program it and integrate it into the control system. Plant personnel will probably continue to be an important link in the control system. If desired . . . will provide the connecting links for complete on-line control . . . immediate assistance should any part of the control system fail . . .

Who should be responsible in the user's organization for applying a computer? It is apparent that a large portion of the problem in control applications is primarily technical in nature. However, the problem involves a judicious balance of both theoretical and practical considerations, and in the final analysis, decisions must be tested against the yard stick of practicality in two critical areas: A computer system must be economical to install, and a computer system must be economical to operate.

This emphasis on the practical is underscored by the fact that installing a computer involves considerably more than just determining a mathematical model and obtaining a suitable piece of equipment. For example, as pointed out above, instruments must be provided or, in some cases, designed. Applying a computer is, in reality, a systems engineering problem for which the user must accept full responsibility.

As time goes by, computer manufacturers can be expected to build up a backlog of knowledge about a variety of processes, and certainly the information will be invaluable in guiding the manufacturer and would-be user. But the nature of the computer as a tool dictates that the user, at the operating level, must acquire a significant understanding of computers that can be blended into his knowledge of processes. Whatever organization that is established in the user's plant must adapt itself to the initial problem of learning about computers, and then proceed to build on the acquired knowledge in applying the computer. The Sun Oil Co., a recognized leader in investigating and applying new concepts in the petroleum industry, has established an Advanced Management and Methods Div. which includes an Applied Physics Section. Included in the latter section is a Computer & Data Processing Unit. It is of interest to note that the companion units within the Applied Physics Section include an Electronic Unit, Scientific Unit, Instrumentation Unit, and a Design Unit. Combining these units into a section emphasizes the systems approach to obtaining improved processes. The particular divisions of effort emphasizes the fact that the application of computers is but one of several problem areas fac-

GENERAL CLASSES OF COMPUTERS

Digital Computers. Most accurate form of computer. Operate on complete numerical value of data expressed in digital form. Circuit logic enables computers to perform arithmetic operations (addition, subtraction, multiplication, division), to compare quantities, and to make logical decisions. Superior tool for handling a large volume of data. Computer facilities can be time-shared. Extremely flexible because of internal programming capabilities. Typical input devices are the keyboard, punched tape reader, punched card reader, magnetic tape reader, analog-to-digital converter, and switches. Typical output devices are logging printers, tape punches, and digital-to-analog converters. Larger forms of general purpose digital computers can perform same tasks as other forms of computers but at expense of greater programming and data preparation effort. Smaller forms of general purpose administrative and scientific machines can also be economically applied to in-process control applications with addition of suitable data converters. Special purpose forms developed to handle problems of limited scope—particularly inventory control problems.

Analog Computers. Accuracy in range of 1 to 2 per cent. Operate on continuous basis as voltage is affected by circuit elements so connected to form an electrical model of a particular system. Perform a variety of mathematical operations including the solving of differential equations for which they are particularly suited. Complexity of machines increases directly as complexity of problems increases, limiting practical applications of the computers. Typically, elements of computer are interconnected by means of patchboard. Output can be displayed on oscilloscope or graph follower. Modular nature of components enables small special purpose control devices to be constructed. Special purpose applications particularly found in military field in such uses as flight controls, computing bomb sights, and flight simulators. Well-known industrial application of a general purpose analog computer is in network analysis.

ing the process engineer in obtaining improved processes.

The existence of a logical, step-by-step approach to a computer control study does not mean that there are no controversial elements in their application. For instance, which is the better approach: A single large computer integrated into a centralized control scheme or several small computing elements arranged in a decentralized system of control? For both a power generating station and petroleum well-pipeline complex the issues might be clear cut; but what of an extensive chemical plant with only a few unstable control loops?

Whatever the considerations, a computer in a control application never appears to be other than a tool—operating 24 hours a day and making its decisions within time rates matching the time factors of the process.

▸ Administrative Applications

When the role of the computer in administrative data processing is assessed, a somewhat different picture emerges: The should-be slave is often revealed as a tyrant! Or in more meaningful terms, certain administrative data processing systems initially have failed to measure up to expectations; the task of making them measure up has proved to be of the first magnitude insofar as effort, time, and money are concerned.

Assuming that outright misrepresentation of equipment capabilities is not involved, the problem must lie with the statement of the expectations or the method of implementation to achieve the expectations. In either instance, it appears that basic responsibility rests with the user. How can companies avoid the pitfalls that other companies have uncovered in establishing electronic data processing systems. Unfortunately, experts offer contradictory advice when details are considered: The payroll operation is an ideal place in which to begin; the payroll operation is a poor place to begin. A systems and procedures man should be responsible; a systems and procedures man should not be responsible for heading up a study.

In general, however, experts do tend to agree that it is important for management to stand back and look at their administrative problems in an objective manner. They also tend to agree that the logical goal to which management should aspire is an "integrated system of data processing." If they begin with a common thesis and reach different conclusions, it must be in the interpretation as to just what is an "objective study."

In any business there is a hard core of essential data that must be handled if the business is to function with any semblance of efficiency. And experience has shown that, in any business, there will be added to this hard core of essential data arbitrary elaborations that represent certain individuals' conceptions of efficiency or solutions to problems. If an objectivity study is to be meaningful, it must aim at penetrating the layer of arbitrary elaborations in data handling and at organizing the handling of the essential data. In the typical company, a significant improvement should be expected from just making the changes indicated by the basic study.

Indeed, such studies have resulted in improvements that, in the words of some observers, "makes it uneconomical to obtain a computer." If this reflects a belief that a computer cannot be justified in a lean system devoid of inefficiencies, it completely misses the point that a computer should only be used in an efficiently organized data handling system.

In essence, the real advantage of the computer in

ROLE OF COMPUTERS IN AUTOMATION

administrative data processing does not differ from its role in control data processing: It contributes to greater efficiency by manipulating and calculating significant data in arriving at optimum solutions to problems which cannot be practically solved by using other tools.

The administrative applications in which computers have proved themselves can be conveniently divided into two major areas. One area might be thought of as being scientific in nature in that it compares favorably with scientific applications of computers. The techniques involved are associated with some of the newer mathematical and investigative procedures including those based on correlation theory, probability theory, queueing theory, linear programming, inventory theory, game theory, and actuarial techniques.

In the second application area, the computer is used as a sort of super bookkeeper. In combination with special techniques for storing or filing information, the data manipulative speed of the computer is exploited to handle great masses of data. The level of calculations normally required in administrative applications is relatively simple. Handling payroll calculations, various accounting operations, and inventory records are examples of uses that fit into this second area.

Study reveals that the failures and marginal successes, in the economic sense, are found amongst the bookkeeping applications. In view of this, it is pertinent to review some of the problems in these applications as identified by users and would-be users. The problems involve management functions, certain technical shortcomings, and costs.

For example, to identify a few specific problems it appears that higher management does not understand the capabilities of computers; information systems must be reorganized to suit the computer; input-output speeds do not match the computer's manipulating and calculating speeds; methods for communicating with the computer system are unsatisfactory; and preparing a program and data for input is both costly and time consuming.

The outlook for solving such problems is good. Technically, computers are continually being improved, as are auxiliary equipment and techniques. Thus great strides are being made in input devices

Equipment Suppliers

Modac Div., Airborne Instruments Laboratory Inc.; Mineola, Long Island, N. Y. Have engineered special purpose digital equipment (MODAC 404, 414) which can be applied to inventory control type problems.

Autonetics, Div. of North American Aviation Inc.; Downey, Calif. Produce a general purpose, transistorized digital computer (Recomp II). Unit is designed primarily for engineering and scientific calculations. Can be applied to process control problems.

Bailey Meter Co.; Cleveland, Ohio. Manufacture both analog and special purpose digital computers for process monitoring; equipment forms part of large scale data handling systems (Metrotype Information Systems).

Bendix Computer, Div. Bendix Aviation Corp.; Los Angeles, Calif. Manufacture commercial type general purpose digital computer (G-15) used for engineering, scientific, and administrative data processing. With appropriate conversion devices can be adapted to on-line process control. Also manufacture a digital differential analyzer (DA-1) which can be operated in conjunction with the general purpose digital computer.

Beckman Instruments Inc.; Fullerton, Calif. Various divisions of company are active in both analog and digital computer fields. Have engineered analog computers for design work in aircraft, missile, and process industries. Also manufacture data processing and computer control systems for industrial, military, and scientific applications.

Electrodata Div., Burroughs Corp.; Pasadena, Calif. Make a variety of digital computers including a low priced, general purpose type (E-101) that is programmed by a pinboard; a moderately priced data processing system (DATATRON 205); and a large scale system (DATATRON 220) which can be provided with a storage capacity for up to 50-million words.

Clary Corp.; San Gabriel, Calif. Developed small computing machine (ECM) around transistorized circuits. Unit is suited to types of problems not economical to run on larger scale analog and digital computers.

Compudyne Corp.; Hatboro, Pa. Engineer data handling and control systems that include analog computing equipment for test facilities and process industries.

Computer Control Co. Inc.; Framingham, Mass. Engineered special purpose digital equipment and computers for variety of industrial and military projects.

Computer Div., Control Data Corp.; Minneapolis, Minn. Manufacture transistorized, large-scale, general purpose digital computer (Model 1604) for scientific and administrative data processing applications. Also expect to apply the computer to real-time data logging and process control problems.

Computer Systems Inc.; New York, N. Y. Build both general purpose and special purpose analog computers and accessories. Included in the line of equipment is a precision analog computer (MC-5800), a general purpose analog computer (MC-5900) for process simulation and control, and a unique analog computer (DYSTAC) that includes a high speed memory.

Daystrom Systems, Div. of Daystrom Inc.; La Jolla, Calif. Produce a solid-state digital computer control system with a guaranteed system operational availability of more than 99 per cent. Systems are used for performance data reduction and automatic control. Expect computer controlled power plant in 1960.

Donner Scientific Co.; Concord, Calif. Builds a medium size analog computer (Donner 3100) which can be applied to analytical, simulation, and control problems.

Electronic Associates Inc.; Long Branch, N. J. Developed small analog computer (PACE TR10) for scientific and control data processing. Also offer larger scale expandable analog computer system (PACE 231R).

Alwac Computer Div., El-Tronics Inc.; Hawthorne, Calif. Produce a general purpose digital computer (ALWAC III) which has been applied to various accounting and scientific research problems.

Electronics Div., Ferranti Electric Inc.; Hempstead, L. I., N. Y. Markets transistorized digital process control computer (Argus) and several administrative data processing systems built around a digital computer (Pegasus).

Epsco Inc.; Boston, Mass. Offer digital computers for control type applications including scanning and logging of process data.

Foxboro Co.; Foxboro, Mass. Market computer controlled process systems built around transistorized digital computer (RCA 110).

Computer Dept., General Electric Co.; Phoenix, Ariz. Active in both administrative and control data processing fields. Recently announced transistorized digital control computer (GE-312) for process control and data logging in industrial and utility systems. Manufactures computer equipment for Bank of America's special ERMA project. Has developed several computer systems (GE-100, 200 series) for various size bank applications. Company also produces analog computers for network analysis.

Genesys Corp.; Los Angeles, Calif. Has developed hybrid digital computer that also contains ability to perform computations by incremental techniques. The equipment (Unit Memory Processor) is designed for process control applications.

Goodyear Aircraft Corp.; Akron, Ohio. Manufacture analog computer (GEDA) that has been applied to load dispatching and control of power station system.

GPE Controls Inc.; Chicago, Ill. Markets a digital computer (Libratrol 500) which is manufactured by Librascope Inc. The control computer is an adaptation of the LGP-30 computer marketed by Royal McBee Corp. for scientific and administrative data processing uses.

and programming techniques. But existing equipment and techniques are pretty darn good; the availability of improved forms is no guarantee that a company will not attempt to use an electronic computer where less sophisticated equipment would suffice. Apparently then, the importance of a thorough and sound feasibility study cannot be overemphasized.

Considering the money which might be spent, the changes which must be made in the data system, and the departments concerned, it is apparent that a feasibility study should always be made under top management guidance.

The detailed knowledge of the over-all operation of the company that is required undoubtedly points to a committee as the best vehicle to use. If there is any possibility of bias creeping into the investigation because of the chairmanship assignment, management is obligated to make the appointment with more than the usual care. The danger to guard against is that narrow scope accounting type applications will be unduly stressed to the detriment of a true systems approach. Indeed, responsible observers have remarked to the effect that they know of no computer installation that can be justified on the basis of accounting-type applications; rather it is only with engineering and technical applications that justification is obtained.

It is clear then that a superior study will result when the most responsible members of the committee are capable of objectively considering the business as an entity; are technically qualified to examine and appreciate the capabilities of computing equipment; are knowledgeable so far as the latest mathematical techniques for dealing with business type problems; and are familiar with factors and considerations that apply to large scale equipment acquisition studies aimed at obtaining greater efficiencies. It should always be uppermost in management's thoughts that, when properly used, the computer can upgrade the art/science of decision making in administrative operations.

The list of manufacturers accompanying this article covers some of the companies that supply major equipment items for data handling systems. By no means is it meant to be a total listing of all companies nor a comprehensive listing of what the indicated companies offer. However, the scope indicated by the list does convey the desired impression that a large variety of equipment is available to satisfy the requirements of would-be users in search of efficient systems.

Hagan Chemicals & Controls Inc.; Pittsburgh, Pa. Manufacture data processing system (Kybernetes) which includes analog computing elements where needed. Systems are applied to industrial logging and monitoring operations.

Information Systems Inc.; Skokie, Ill. Market general purpose digital computer system (ISI609) suitable for all types of administrative and scientific data processing including the solution of industrial control problems.

Electronic Equipments Div., Litton Industries; Beverly Hills, Calif. Active in developing military systems in which special purpose computers are required. Company has engineered a digital differential analyzer (Litton 80-DDA) for use in process control studies.

International Business Machines Corp.; White Plains, N. Y. Manufacture a wide range of equipment used in scientific and administrative data processing. Included in their equipment line are transistorized calculators, magnetic drum data processing machines (IBM 650), data processing systems (IBM 705), random access systems (IBM 305 RAMAC), high speed transistorized systems (IBM 7070), and large-scale transistorized systems (IBM 7090).

Leeds & Northrup Co.; Philadelphia, Pa. Engineered application of various analog computers to military and power generating station problems. Jointly developed transistorized digital computer (LN 3000) with Philco Corp. for control applications.

Minneapolis-Honeywell Regulator Co.; Philadelphia, Pa. Various divisions engaged in manufacture and development of both analog and digital computers. Manufacture general purpose transistorized digital computer (Honeywell 800) for administrative applications. Have described special digital computer (D-290) for control of electric generation station. Developed a number of analog computers for industrial and process control applications as well as network analyzers.

Electronics Div., Monroe Calculating Machine Co.; Morris Plains, N. J. Developed special purpose digital computer system (Distributape) for problems involving summarizing and analysis of quantities of business and statistical data. Output of unit is punched paper tape. Also manufacture a small desk size computer (Monrobot IX) for administrative data processing.

National Cash Register Co.; Dayton, Ohio. Offer a large scale digital computer data processing system (NCR-304). Computer circuits utilize transistors, diodes, and magnetic cores mounted on plug-in cords. Report development work on small digital computer.

Nuclear Development Corp. of America; White Plains, N. Y. Build special purpose digital computer (NDA Automatic Inventory Control Computer) which can be applied to any problem similar to inventory control problem.

George A. Philbrick Researches Inc.; Boston, Mass. In addition to analog computers, company offers variety of components that enable users to build their own analog computers for special purposes.

Philco Corp.; Philadelphia, Pa. Have engineered large scale general purpose computer system (TRANSAC S-2000) for administrative and scientific data processing.

Quarie Controllers; Canton, Mass. Developed small analog computing machine (Quarie Maximizer) which can maximize or minimize a quantity in process application by adjusting one parameter.

Radio Corp. of America; Camden, N. J. Engineered a high-speed general purpose digital computer system (BIZMAC) for administrative data processing. Also developed transistorized digital computer (RCA 501) for business, industrial, and government use. For industrial process control, manufacture transistorized digital computer (RCA 110) system.

J. B. Rea Co.; Santa Monica, Calif. Offer a medium range general purpose digital computer (READIX) in which internal operation is in decimal number system, with each decimal digit represented by four binary bits.

Remington Rand Univac Div., Sperry Rand Corp.; New York, N. Y. Produce a variety of digital computer systems including, for example, a low-priced general purpose computer (UNIVAC 120) moderately priced large capacity system (UNIVAC File Computer O & I), and a high speed, general purpose large scale system (UNIVAC II).

Royal McBee Corp.; Port Chester, N. Y. Market a small scale general purpose digital computer (LGP-30) which is manufactured by Librascope Inc. Unit is designed to handle scientific and engineering type problems. Also offer transistorized general purpose digital electronic computing system (RPC-4000) for scientific and administrative data processing.

Southwestern Industrial Electronics Co.; Houston, Tex. Manufacture a general purpose analog computer (CM-2) suitable for use in computing process variables and for control in chemical, petrochemical, and refinery work.

Tally Register Corp.; Seattle, Wash. Engineered various digital data display and editing systems; has also engaged in research and development work on components and digital computer systems for commercial applications.

Teleregister Corp.; Stamford, Conn. Engineered Special inventory type control systems which involve digital data processing.

Thompson-Ramo-Wooldrige Products Co., Div. of Thompson Ramo Wooldridge Inc.; Los Angeles, Calif. Developed a digital control computer (RW 300) for automatic data reduction and automatic control in variety of industries.

Electronic Computer Div., Underwood Corp.; Long Island City, N. Y. Developed a low-price digital computer (UEBC-100) for bookkeeping and accounting type applications.

Westinghouse Electric Corp.; Pittsburgh, Pa. For process control applications have developed unique control unit (OPCON) which is capable of searching out optimum relationships of variables. Manufacture analog computer units for automatic dispatching system control.

AUTOMATION TODAY

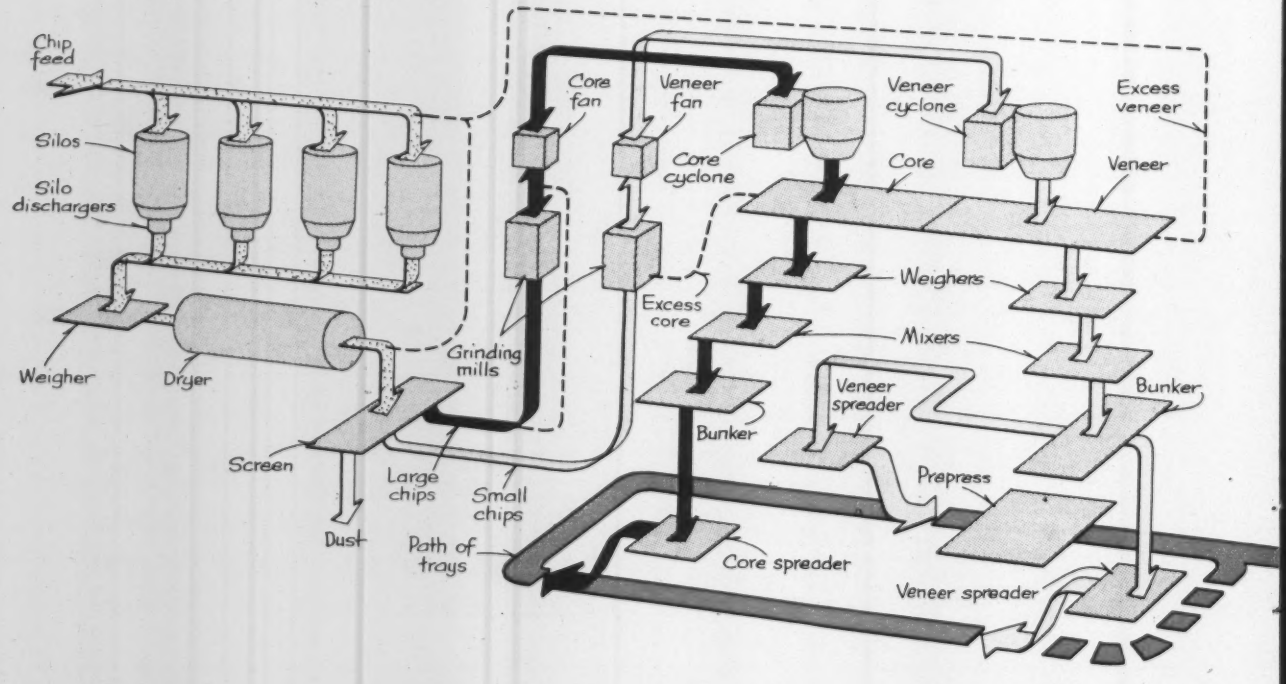
PROCESSING CHIPS INTO CHIPBOARD

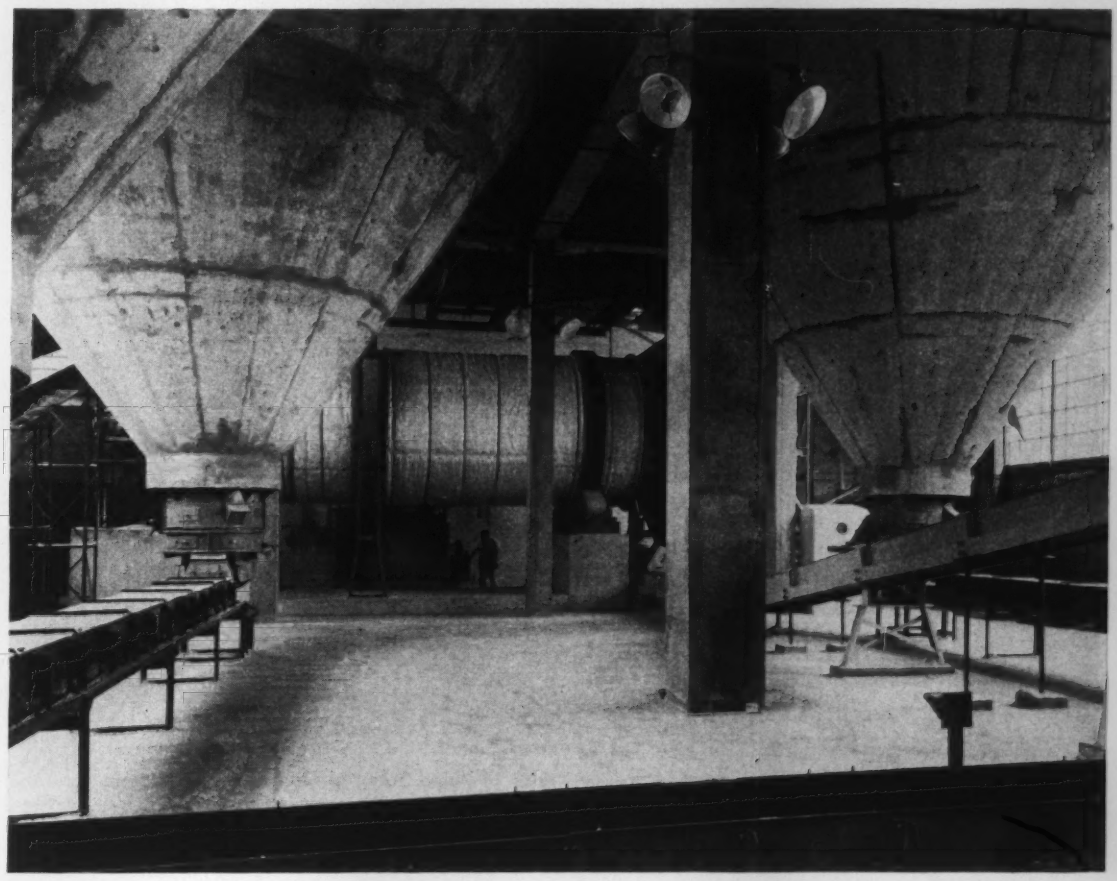
By **LEO WALTER**, Consulting Engineer, Painswick, Nr. Stroud, Gloucestershire, England

PROCESS scrap has a habit of becoming process byproduct as the cost of raw material continues to spiral upward each year. When the cost of raw material is low, scrap or waste from a process can usually be thrown away since the cost of reclamation normally exceeds the expected gain derived from converting the waste into a useful product. However, as the cost of raw material rises, an economic breakeven point is reached where it is advantageous to utilize the scrap. This breakeven point can usually be reached faster by applying the concepts of automation to the reclamation process.

For example, at a plant of British Plimbers Ltd. in Rainhaim, Essex, England, scrap wood chips are being used in the manufacture of two types of chipboard. One type is a homogeneous board made from chips of the same general particle size. The second

1 Diagram illustrates the automatic system whereby scrap wood chips are converted into pressed chipboard at a minimum of cost. The entire process is automatically controlled from two master control panels, and relatively little direct labor is required to keep the process operating. The system is designed to handle a throughput of approximately 10,000 pounds of chips per hour.

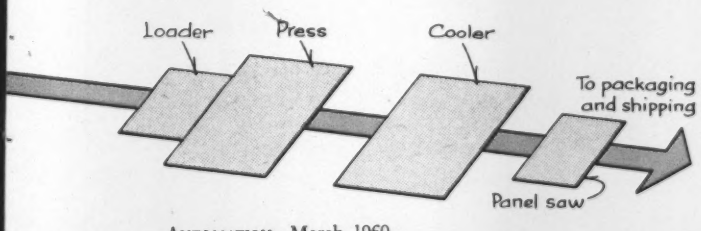




2 Chips from various suppliers are stored in four large silos. Outlets of two of the silos are shown in this view. Discharging units controlled by a weighing machine, automatically release chips to the system from the silos. Chips are conveyed at a preset rate to the rotary drying unit in the background where the chips are dried to a uniform moisture content. After drying, the chips are passed through a screening machine and small chips are separated from large chips.

type is a "sandwich" board consisting of a mixture of chips in three layers. Small size chips such as are used in the homogeneous board form the two outer layers of the board. The center layer of the sandwich board is composed of larger chips of varying sizes.

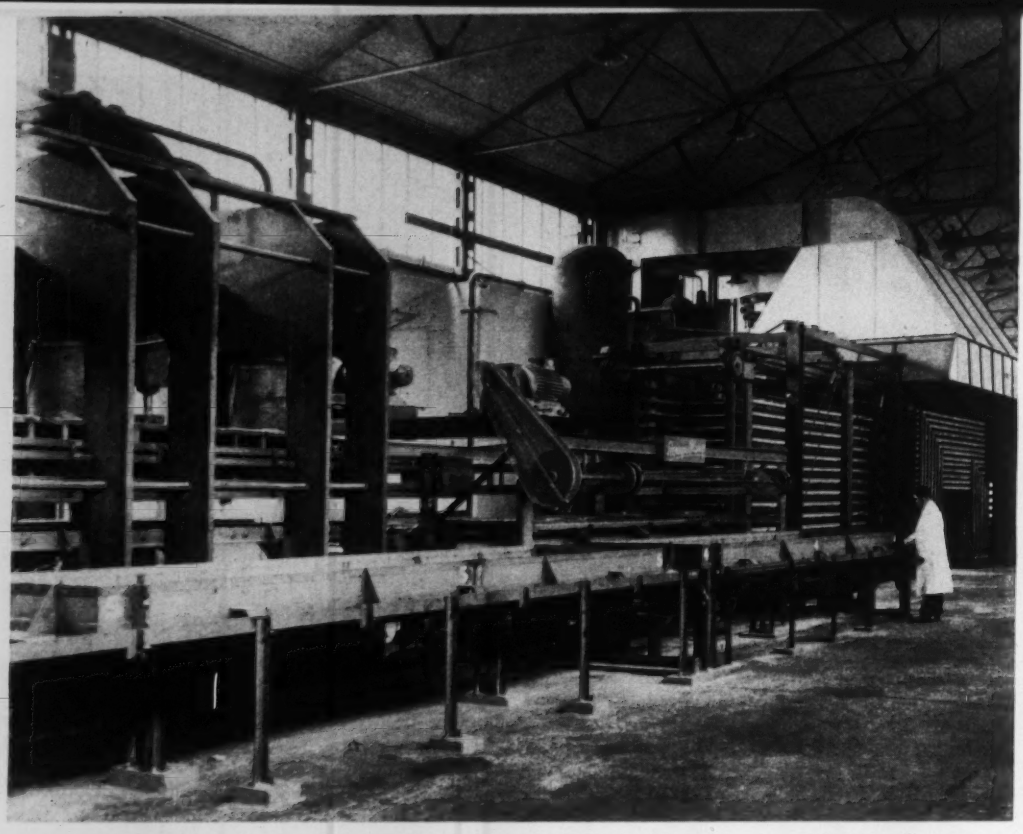
As a result of years of research, the British company has introduced a high degree of automatic operations into the reclamation process. Equipment built by Wm. Gardner & Son Ltd. of Gloucester can transform wood chips of varying particle sizes and densities from many sources of supply into valuable chipboards at a minimum of cost and with little direct labor. The system has been designed to handle a throughput of approximately 10,000 pounds of chips per hour.



Chip Preparation

Upon receipt from suppliers, wood chips are conveyed pneumatically into four large silos. During this transfer operation, the chips are passed through cleaning separators in which string and large pieces of wood are removed. At this point no separation is maintained between chips of varying sizes or densities.

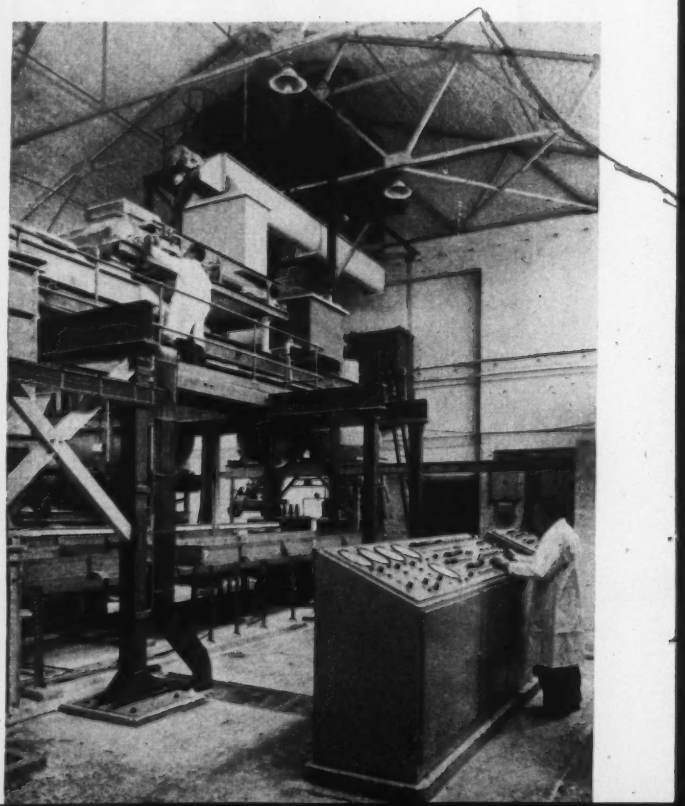
Chips are removed from the silos by discharging units, which are designed to prevent chips from arching over the discharge outlets. Each discharging unit is driven by a variable speed drive so that the output from each silo can be accurately controlled. As chips are withdrawn from the silos, they are mixed together and conveyed to an automatic weighing machine. This machine is equipped with electronic controls which regulate the variable speed drives on the discharging units so that chips are



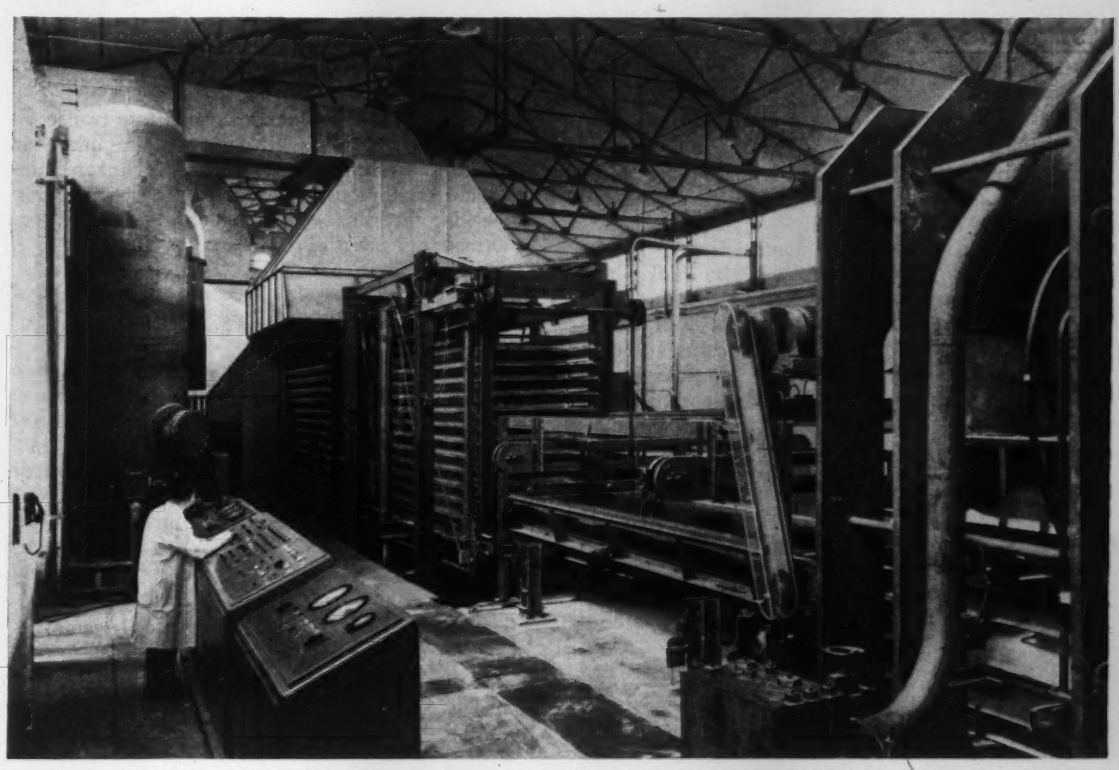
3 From the screening machine the two sizes of chips are conveyed through separate grinding mills to segregated storage bunkers ahead of the chemical coating systems. In the meantime, the two-piece trays are prepared to receive layers of chips. From left to right in this view can be seen the prepress structure, the tray transfer structure which moves the tray parts laterally from the opposite side of the system to the tray assembly point on this side, the hot press loader, and the hot press at the far right. The operator is standing at the point where the tray parts are joined together. A conveyor system then moves the trays to the left and carries them under three spreaders which distribute layers of chips.

delivered to the next processing step at a preset rate. Control of this type is necessary since different shipments of chips from suppliers will sometimes vary in density.

From the weigher the chips are conveyed continuously into a rotary drying unit. In this unit, the temperature is controlled automatically so that



4 From segregated storage bunkers the small and large chips separately feed into mixers where they are coated with resin, hardeners, and other chemicals. They are then temporarily stored in bunkers until needed in the process. This view shows one of the two mixing-coating systems located above the tray handling system. When 3-layer chipboard is being processed, coated small chips are delivered to a weigher spreader which distributes the chips in the bottom of a tray. Coated large chips are dispensed by a second weigher spreader to form the center layer of the board. A third spreader applies a top coat of small chips to complete the board formation. In the process, the trays move in a continuous conveyor loop, and each spreader is actuated in turn.



5 Chip material in the trays is prepressed into self-supporting biscuits in the structure located in the right foreground. The tray sides are then removed and transferred to the opposite side of the machine by the low structure following the prepress. Each biscuit is next slid into the loading machine in the center background. This mechanism automatically raises itself to a new position as each biscuit is loaded. When twelve biscuits have been loaded, the loading machine moves the materials into the hot press under the large hood. After the loader has retracted, leaving the biscuits in the press, the press applies pressure and heat to each biscuit, forming the mass into chipboard.

the final moisture content of the chips is constant irrespective of the initial moisture content of different lots in the silos. The amount of moisture removed from the chips is determined by sensing the temperature of hot gases leaving the dryer. This measurement is used to control an oil-fired heater for the dryer.

Dried chips are next delivered to a screening machine which has two functions to perform. First, the machine removes any dust from the chips since foreign materials could reduce the quality of the chipboard. Second, the machine separates the chips into two grades. One grade consists of small size chips which are of the correct size for forming either homogeneous board or the outer veneer layers of 3-layer board. The second grade consists of larger chips which can be used as the center layer in sandwich board or can be ground into smaller chips for use in homogeneous board. At the present time, the plant is producing mostly homogeneous board from small size chips. However, it is expected that a gradual changeover to 3-layer board will be made in the future since high-strength board can be made of a lower density than is possible with homogeneous board. At the same time, the 3-layer board retains a surface quality equal to that of homogeneous board.

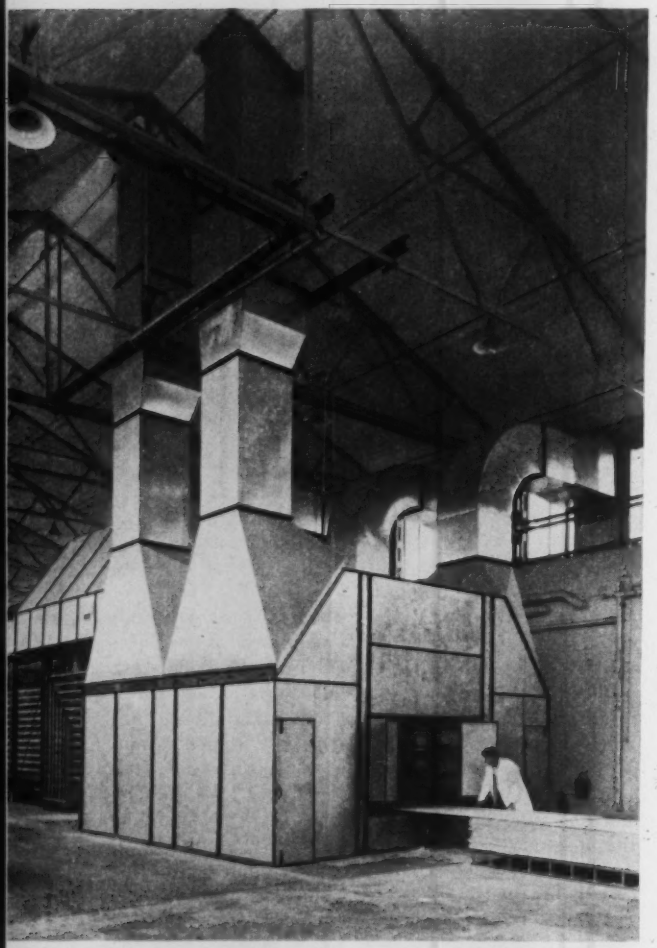
When only homogeneous board is being processed, the large size chips which have been separated by the screens are fed through a grinding mill and are reduced to small chips. These chips are then delivered to a storage bunker along with the small chips that were originally screened out. When 3-layer board is being processed, the small chips are delivered to one part of the storage bunker, and the large chips are conveyed to another section of the same bunker. The two sizes of chips are kept separated by a divider plate inserted in the bunker. In either case, an internal agitator in the bunker keeps the chips moving slowly and in a "live" condition so that they can be withdrawn easily.

Each section of the bunker is fitted with an overflow outlet in addition to its main discharge outlet. When chips in either section of the bunker rise above a normal storage level, excess chips fall into the overflow outlets and are carried back into the chip supply system. Small chips move directly

back to the storage silos. Large chips are delivered into a grinder which transforms them into small chips.

According to the requirements of the process, both sizes of chips are drawn from the bunker and are delivered to separate automatic weighers. These units control the delivery rate of the chips to the next process step. The two sizes of chips are then fed to separate mixers where they are coated with liquid resin, hardener, and other chemicals. The rates of input of the coating materials to the mixers are automatically controlled by the input weighers so that as the input of chips changes, the input of coating materials also changes proportionally.

The coated chips are next delivered into two separate bunkers, one for small chips and the other for large chips. While stored in these bunkers, the chips are continuously agitated to prevent sticking or packing. At this point, the chips are ready to be formed into sheets of chipboard.



6 From the hot press, left of picture, the completed chipboard is automatically unloaded into this cooling unit. After a period of time during which the boards are air cooled, the chipboards are discharged from the cooling unit one at a time and stacked on a skid. The cooling unit unloading mechanism is similar to the automatic press loader in that the mechanism lowers each time a board is discharged.

Forming Chipboard

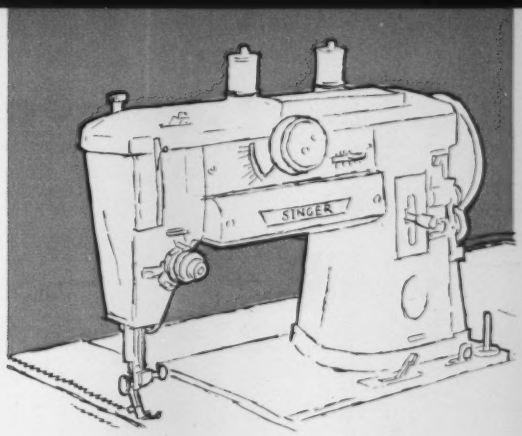
Chipboard is formed in a series of two-piece trays which circulate on a track beneath three weigher spreaders fed from the chip storage bunkers. In the manufacture of 3-layer board, one weigher spreader applies a bottom layer of small chips in each tray, the second spreader lays a center layer of large chips, and the third spreader applies a top layer of small chips. When homogeneous board is being processed, all three spreaders apply layers of small chips.

The trays move forward automatically, and, as they pass under each weigher spreader, each unit is actuated and applies a layer of chips in the tray from end to end and from side to side. When the tray moves past the feed point of each spreader, the unit automatically stops. After a tray has received all three layers of chips, it is conveyed into a prepressing unit. This press operates without heat and consolidates the chips into a biscuit which is sufficiently firm to be handled without support.

As the tray is conveyed out of the prepress, the upper portion of the tray is removed and transferred laterally to the opposite side of the continuous loop conveyor. The chipboard biscuit is then pushed off the tray bottom into a loading machine for the final hot press. The tray bottom is transferred laterally, and the upper portion is replaced on it, ready for formation of another chipboard biscuit. As each biscuit is moved into the loader machine, the mechanism automatically raises itself to a new position to receive the next biscuit. When the loader has been filled with twelve biscuits, it has been raised sufficiently for entry into the final hot press.

The hot press automatically opens, and the loader machine moves forward into the press. As the loader retracts from the press, the biscuits are retained in the press. The press then closes and applies pressure and heat to each biscuit, consolidating and sealing the mass into a piece of chipboard.

After pressing, the boards are automatically unloaded into a cooling unit where cool air is blown over the surfaces of each board. An unloading mechanism in the cooling unit then starts discharging the chipboards one at a time for stacking on a skid. This mechanism is similar to the hot press loading unit in that it lowers step by step so that each board is discharged at a convenient handling level. After visual inspection, the chipboards are delivered to a saw for edge trimming and cutting to shipping sizes.



PROGRAMMED CONVEYOR SYSTEM

INTEGRATES FINISHING OPERATIONS

Behind many manufacturing innovations is often found a carefully planned and executed cost reduction program. The integrated handling system described in this article was conceived, economically justified, and installed as a part of a broad scope cost reduction effort. The many automatic features of the handling system are essential to full realization of the savings potential uncovered in the study.

By **WILLIAM C. HAYES,** Assistant Works Manager, The Singer Mfg. Co., Elizabethport, N. J.

FACED on the one hand with increasing competition from countries with low labor rates, and on the other with growing costs of domestic production, the Singer Mfg. Co. has embarked on a cost reduction study of its U. S. operations. Early in the study it became apparent that modernization of manufacturing facilities and standardization of product line would be basic to any cost reduction effort.

In the product standardization phase of the program, six classes of household sewing machines were replaced by one basic machine in several models. This paved the way for manufacturing improvements, since parts production was thereby increased sufficiently to justify converting from job-lot type operations to mass production in many areas.

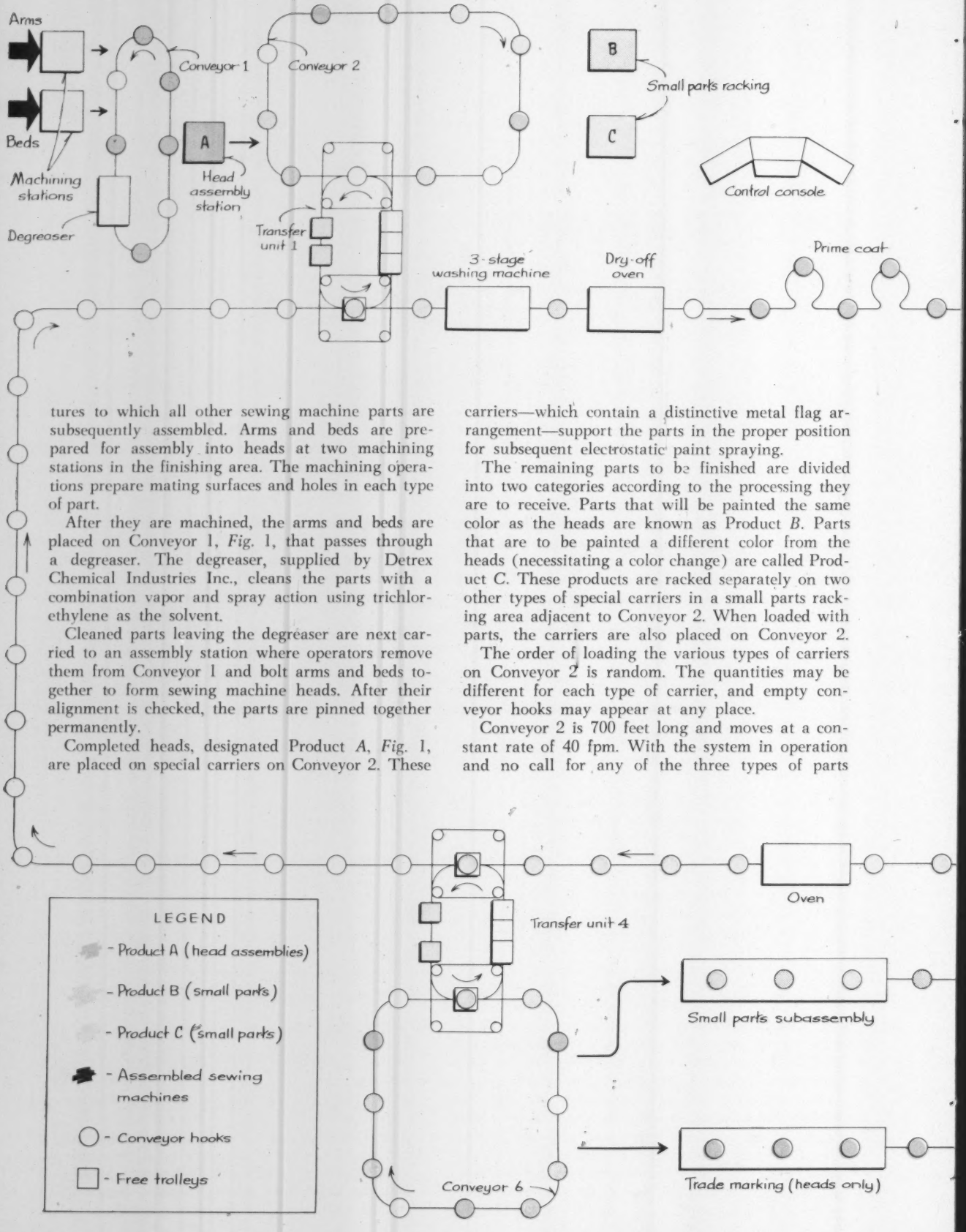
A particularly fruitful opportunity for cost reduction was found in the finishing area where painting and ornamenting operations are carried out. Previously, this work was performed on a jobbing basis with many hand operations for washing, degreasing, painting, and baking the sewing machine parts and subassemblies. By converting to electrostatic painting, and conveyorizing the handling of all parts for finishing, these operations could be carried out automatically.

The integrated handling system that was devised, *Fig.* 1, is of interest because of its many automatic features. It includes eight separate, continuously operating, overhead conveyors and four automatic transfer units. The transfer units interconnect four of the conveyors and provide a means of automatically transferring parts carriers from one conveyor to another.

Finishing Operations

Seven types of parts, including four aluminum diecastings, two sheet metal parts, and a sand casting, are processed through the finishing area served by the handling system. These parts are brought to the finishing area from associated diecasting, press, and foundry departments in other buildings.

Two types of aluminum diecastings, known as arms and beds, form sewing machine heads when they are assembled. The heads are the basic struc-



tures to which all other sewing machine parts are subsequently assembled. Arms and beds are prepared for assembly into heads at two machining stations in the finishing area. The machining operations prepare mating surfaces and holes in each type of part.

After they are machined, the arms and beds are placed on Conveyor 1, *Fig.* 1, that passes through a degreaser. The degreaser, supplied by Detrex Chemical Industries Inc., cleans the parts with a combination vapor and spray action using trichlorethylene as the solvent.

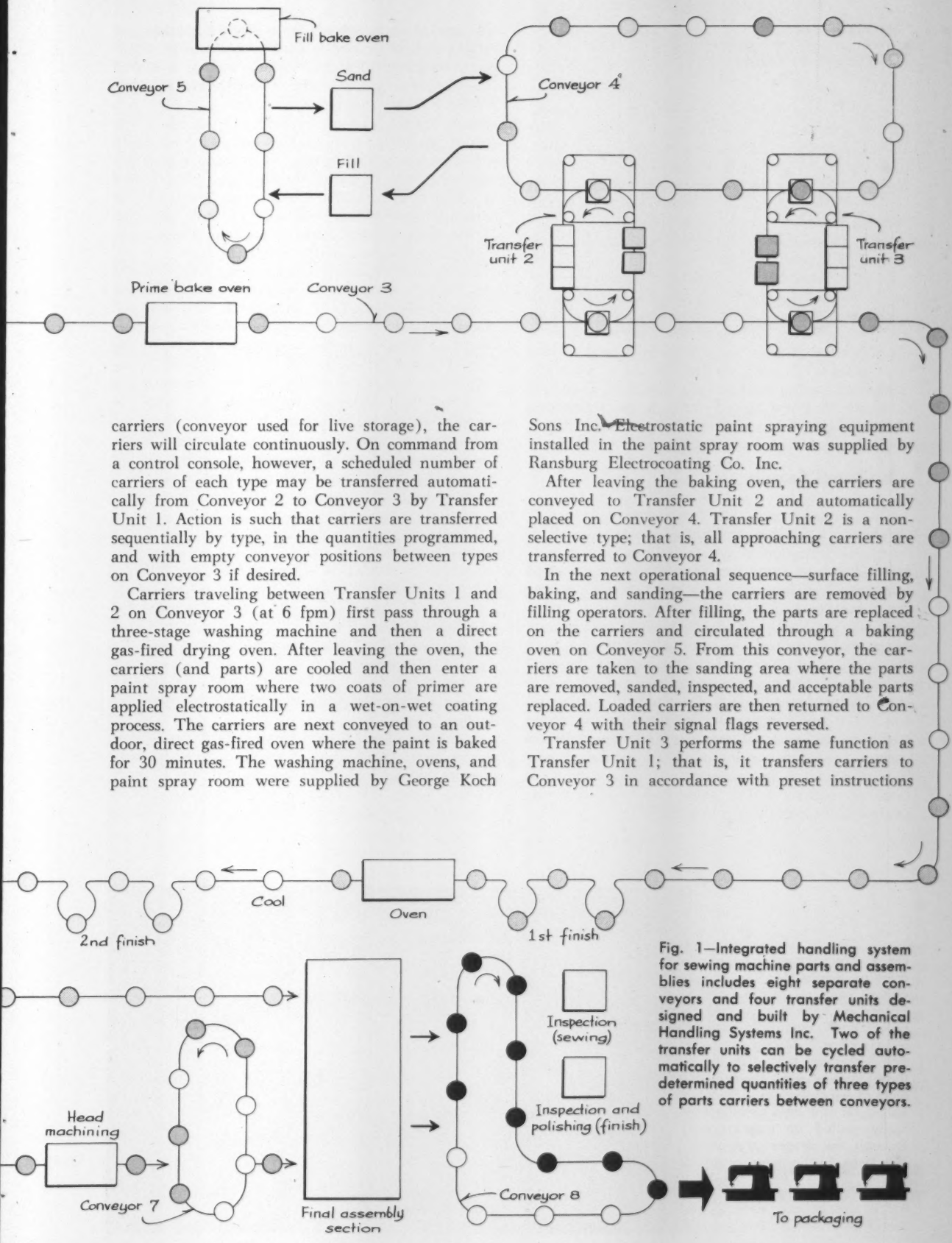
Cleaned parts leaving the degreaser are next carried to an assembly station where operators remove them from Conveyor 1 and bolt arms and beds together to form sewing machine heads. After their alignment is checked, the parts are pinned together permanently.

Completed heads, designated Product *A*, *Fig.* 1, are placed on special carriers on Conveyor 2. These carriers—which contain a distinctive metal flag arrangement—support the parts in the proper position for subsequent electrostatic paint spraying.

The remaining parts to be finished are divided into two categories according to the processing they are to receive. Parts that will be painted the same color as the heads are known as Product *B*. Parts that are to be painted a different color from the heads (necessitating a color change) are called Product *C*. These products are racked separately on two other types of special carriers in a small parts racking area adjacent to Conveyor 2. When loaded with parts, the carriers are also placed on Conveyor 2.

The order of loading the various types of carriers on Conveyor 2 is random. The quantities may be different for each type of carrier, and empty conveyor hooks may appear at any place.

Conveyor 2 is 700 feet long and moves at a constant rate of 40 fpm. With the system in operation and no call for any of the three types of parts



carriers (conveyor used for live storage), the carriers will circulate continuously. On command from a control console, however, a scheduled number of carriers of each type may be transferred automatically from Conveyor 2 to Conveyor 3 by Transfer Unit 1. Action is such that carriers are transferred sequentially by type, in the quantities programmed, and with empty conveyor positions between types on Conveyor 3 if desired.

Carriers traveling between Transfer Units 1 and 2 on Conveyor 3 (at 6 fpm) first pass through a three-stage washing machine and then a direct gas-fired drying oven. After leaving the oven, the carriers (and parts) are cooled and then enter a paint spray room where two coats of primer are applied electrostatically in a wet-on-wet coating process. The carriers are next conveyed to an outdoor, direct gas-fired oven where the paint is baked for 30 minutes. The washing machine, ovens, and paint spray room were supplied by George Koch Sons Inc. Electrostatic paint spraying equipment installed in the paint spray room was supplied by Ransburg Electrocoating Co. Inc.

After leaving the baking oven, the carriers are conveyed to Transfer Unit 2 and automatically placed on Conveyor 4. Transfer Unit 2 is a non-selective type; that is, all approaching carriers are transferred to Conveyor 4.

In the next operational sequence—surface filling, baking, and sanding—the carriers are removed by filling operators. After filling, the parts are replaced on the carriers and circulated through a baking oven on Conveyor 5. From this conveyor, the carriers are taken to the sanding area where the parts are removed, sanded, inspected, and acceptable parts replaced. Loaded carriers are then returned to Conveyor 4 with their signal flags reversed.

Transfer Unit 3 performs the same function as Transfer Unit 1; that is, it transfers carriers to Conveyor 3 in accordance with preset instructions

Fig. 1—Integrated handling system for sewing machine parts and assemblies includes eight separate conveyors and four transfer units designed and built by Mechanical Handling Systems Inc. Two of the transfer units can be cycled automatically to selectively transfer predetermined quantities of three types of parts carriers between conveyors.

from the control console. After they are transferred, the carriers proceed on Conveyor 3 through first enamel coating, baking, cooling, second enamel coating, and second baking operations.

After the paint finishing operations have been completed, the carriers are conveyed to nonselective Transfer Unit 4 where they are automatically transferred to Conveyor 6. There, they circulate until needed by assembly or trademarking operators.

From Conveyor 6, painted small parts are removed by subassembly operators, assembled as required, and passed to a final assembly section. Heads are removed from Conveyor 6, trademarked by a silk-screening process, final machined, and placed on Conveyor 7 until needed for final assembly. Completed sewing machines are placed on Conveyor 8, where they are routed through two inspection stations before being removed for packing.

Control Console

The control console, *Fig.* 2, is designed to include provision for flexible program planning as well as for visual indication of system failures. The console is divided into three sections. The center section contains all of the controls for starting and stopping the conveyors and for cycling the transfers, and a bank of indicating lights. Wing sections contain programming controls for the paint conveyor with the prime coat controls in one wing and the controls for the finish coats in the other wing.

Indicating Light System. The indicating light system in the center section of the control console shows which conveyors are operating, and also indicates various conditions or malfunctions in the system. It is designed so as to instantly indicate the locations of troubles and is color coded to show the relative seriousness of such troubles.

Green is used to indicate a normal running or cycling condition. Red is used to indicate an emergency condition of serious nature, such as a broken chain or shear pin, a mechanically overloaded drive, a failure of air supply on the chain take-ups, or a missed transfer. Yellow is used to indicate a less serious condition such as a motor overload which will be reset automatically, or a manual interlock which has been operated by personnel. Blue is used to indicate a condition which must eventually be corrected, but which will not prevent operation of the system. This color is used to indicate the need for adjustment in the chain take-ups.

Emergency stops are located throughout the system. These stops are of the manual reset type. Where a considerable length of conveyor is involved, pull chains are used to operate switches requiring manual resetting. When a particular conveyor is stopped, the control circuit automatically stops associated transfers in the manner providing the least disruption of programming. Although each conveyor may be stopped at several locations, it may be re-started only from the main console, and then only if the button or switch has been manually reset out on the system to indicate that the trouble has been cleared. Lights on the console indicate the condition of these manual stops.

Disconnect switches are located at each motor in the system. When a motor requires servicing, the maintenance electrician opens its switch, signalling the console that this motor is out of service. Interlocks prevent operation of the proper conveyor and associated transfer. Motor starters are equipped with self-resetting overload elements which signal the console when they have dropped out their motors. Operation of a reset button will darken the indicating light only after the overloads have automatically reset.

Scanning switches are used to test the indicating lamps for burnout, thus providing a quicker check than would have been possible by the use of "push-to-test" lights. Indicator lamps with message discs are used to reduce the information on the indicator

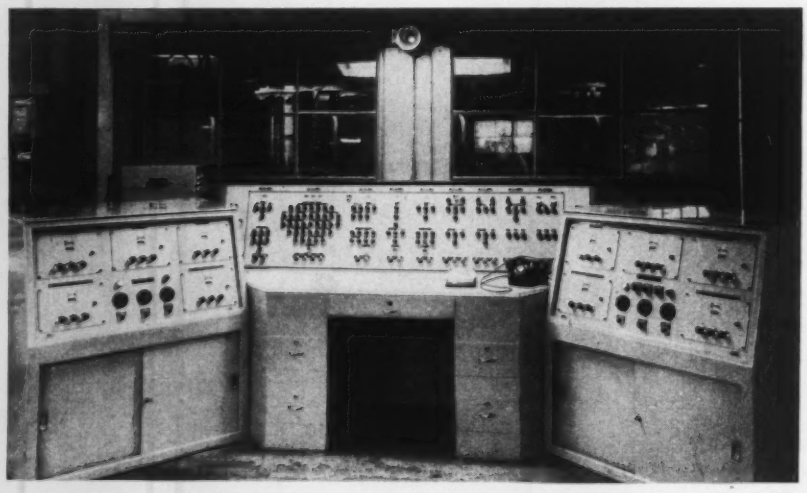


Fig. 2—Control console developed by Singer Mfg. Co. engineers contains trouble light system in center section and programming controls in each wing section. Day's production schedule for each of three types of parts is set on dials of wing sections. Parts called for are then automatically routed on conveyors through the proper processing steps in finishing area.

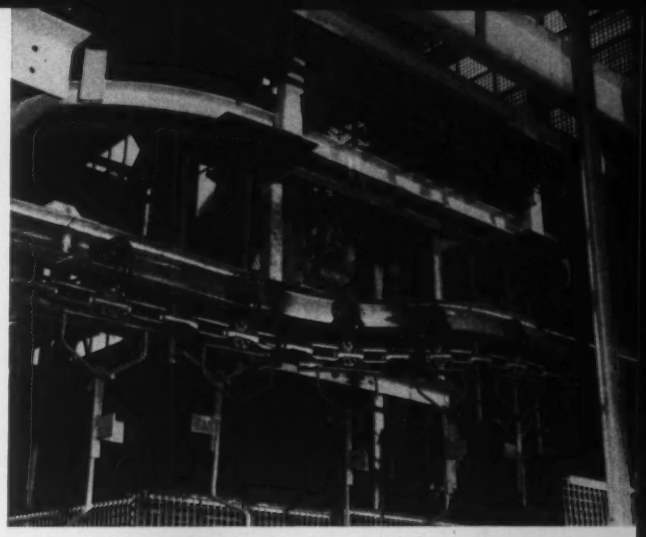
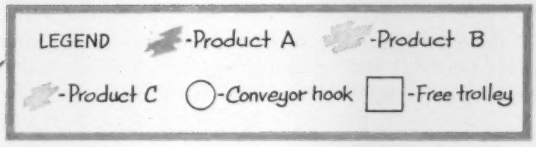
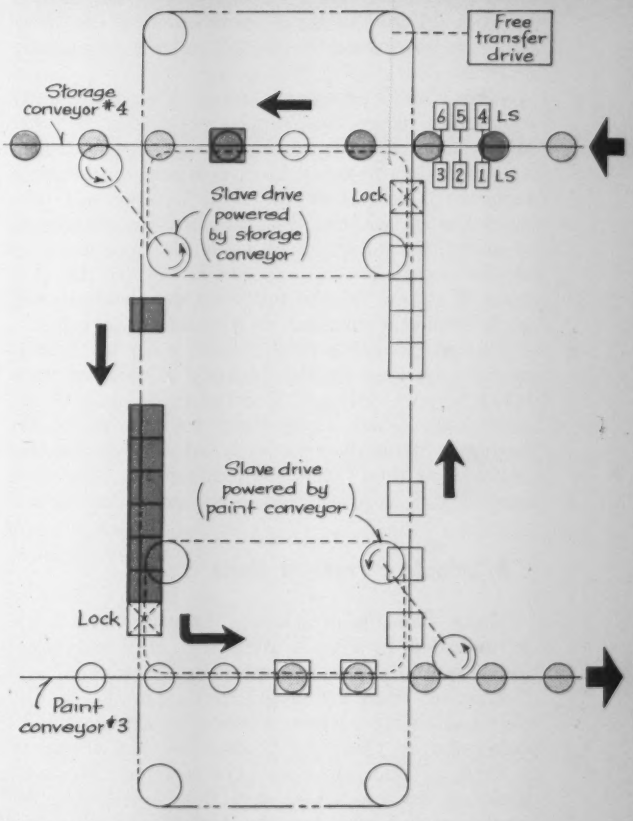


Fig. 3—Close-up of one end of selective transfer unit shows two free trolleys (identified by square plates in center) in process of removing parts carriers from storage conveyor (chain unit conveying flagged carriers to left). Carriers will be transferred automatically to paint conveyor at opposite end of transfer unit. Diagram illustrates major elements of transfer unit that moves parts carriers selectively by type, in the quantities programmed, from Conveyor 4 to Conveyor 3.





plates above the lamps. For example, the *type* of fault is indicated on the plate and the *location* of the fault on the message disc.

Since every type of fault has already occurred on the system, either during setup or in production running, the indicating light panel has proved to be a valuable asset.

Programming Controls. Each control console wing section contains programming controls whereby each of the three different types of carriers may be transferred from a storage conveyor to the paint conveyor in a given sequence and quantity. Selector switches determine the sequence in which the three types are to be transferred, and predetermining counters determine the quantity of each type, as well as the number of empty hooks to be provided between each type to allow time for changing paint color or volume.

Each program set on the console must call for one run of each type (the quantity may be zero for any type). An improper program cannot be started and will be indicated by an "improper program" light. A correct program is indicated by a "ready to run" light, and once started will be locked. Operation of the sequence switches will not change the program, but will indicate that the switch settings do not agree with the program by lighting the "improper program" indicator.

During the run of the first type, the program can be unlocked to permit changing the sequence of the second and third types. Once the second type has started, the program is locked until completed. Quantities may be changed while the program is running simply by changing the dial settings on the counters.

When a correct program has been set, carriers of the first type in the program will enter the transfer unit and move down to the lock at the paint conveyor. However, delivery to the paint conveyor will not start immediately, since a steady flow of work is required through the spray booths. When the transfer unit has stored enough carriers to operate two limit switches, delivery will start. However, if a program is completed without operating the choke switches, the transfer unit will deliver. If the storage conveyor has too few carriers of the type being delivered to the transfer unit and the supply drains down to a point where steady flow to the paint conveyor is endangered, operation of a limit switch will signal the controls, and the next type in the program will be called for. The counters will indicate the actual amount of each type delivered, even though this may disagree with the initial program.

When the first type has been transferred in the quantity set by the program, the counter will signal

the controls to start delivery of the second type. This signal is accomplished by a commutator which matches the count as pulsed by the transferring carriers with the count as dialed into the program.

Each succeeding type of carrier will immediately follow the preceding type on the transfer unit. However, when the first carrier of a new type reaches the lock at the paint conveyor, the lock is prevented from opening and the control is shifted to a counter which is pulsed by limit switches operated by hooks on the paint conveyor. This provides empty spaces between different types of parts entering the spray booths to allow time for changes in color or quantity of paint.

When a day's program is started, there is normally some delay before the paint conveyor is loaded, due to the fact that the transfers must first be filled. To eliminate this delay in cases where the program sequence is to remain the same on the next day, a selector switch has been provided in each wing to allow the automatic filling of the transfer units at the completion of a program. When the program is started on the following day, carriers will be immediately released to the paint conveyor.

The programming of the finish coats also makes special provision for the painting of rejected parts which require only one finish coat in place of the normal two coats. These parts are put on carriers having a signal flag on each side. When selector switches on the console are properly set, only these carriers will be transferred to the paint conveyor.

Selective Transfer Units

Major elements of selective Transfer Unit 3 are as indicated in *Fig.* 3. Both this unit and selective Transfer Unit 1 operate in accordance with instructions from the programming console. As carriers containing various products approach in random order on Conveyor 4, their flags are sensed by a bank of limit switches (1*LS* through 6*LS*). Of these six limit switches, only those identifying desired carriers in the desired orientation on Conveyor 4 are energized by the programming console.

When a desired carrier has been sensed by the limit switches, an air-operated lock on the transfer unit is opened. This releases a free trolley so that it can be engaged by a slave drive chain powered by Conveyor 4. Motion of the free trolley is synchronized with that of the desired carrier so that they meet and travel together until the transfer is effected.

Transfer of the desired carrier occurs when the track for Conveyor 4 dips downward with the free trolley pacing the carrier. This causes a hook on one side of the carrier to engage the free trolley while a hook on the other side is disengaged from Conveyor 4. With the carrier on the free trolley, the trolley is moved to a second air-operated lock that serves to accumulate carriers of the desired type. The last portion of the trolley motion is supplied by a chain system carrying rubber lugs that engage and push the trolleys into place.

When the programmed quantity of carriers has been accumulated at the second air lock, the lock opens and the free trolleys are released to be carried by a slave drive chain powered by Conveyor 3. The trolleys are thus moved parallel with Conveyor 3 until another transfer is effected. The carriers then proceed on Conveyor 3 and the trolleys are returned to the first air lock in the transfer unit.

Limit switches spotted throughout the transfer unit perform sensing, counting, and synchronizing functions. For example, limit switches sense the arrival of free trolleys at the locks and close the locks until the trolleys are needed; other limit switches count spaces between product types, withholding feeding of a new type to Conveyor 3 until the desired count has been reached; and still other limit switches override the transfer unit controls to permit "stray" carriers approaching on Conveyor 3 to pass through. Mechanical failures such as broken shear pins and chains are also sensed by limit switches.

Missed Transfers

A carrier that has failed to transfer properly will signal at the console by means of an audible alarm as well as by indicating lights. Automatic controls will be initiated to provide for continued operation of the conveyors without damage for as long as possible. The audible alarm may be turned off immediately at the console, but the indicating light will remain lighted until a reset button has been operated at the location of the missed transfer.

Carriers that are not taken off the paint conveyor due to a missed transfer will pass through Transfer Unit 1 (which is loading the paint conveyor). If too many misses occur in a row, the paint conveyor will stop.

A carrier that is retained on a free trolley when the trolley returns to its collection point will be signalled immediately at the console. When this carrier is about to enter the lock at the storage conveyor, another signal will be given and the lock will be prevented from opening. The carrier should be removed at this point. However, for some time the storage on the other side of the transfer will continue feeding the paint conveyor. When this storage has drained halfway down, a third signal will be given and the transfer will be stopped. The paint conveyor will continue running, although it will receive no more work from the stopped transfer.

A carrier that is not delivered to a storage conveyor due to a missed transfer will be signalled immediately at the console. When this carrier is about to enter the lock at the paint conveyor, another signal will be given and the lock will be prevented from opening. The transfer will continue running.

TAPE CONTROLLED DRILLS CUT PRODUCTION COSTS

USING two numerically controlled turret drills, Chandler Evans Corp. of West Hartford, Conn., has reduced labor costs by 50 per cent, cut scrap losses by 13 per cent, and lowered over-all tooling costs by approximately 40 per cent on drilling operations for aircraft engine accessories. Such savings are expected to make possible a two-year pay-back for both drilling machines.

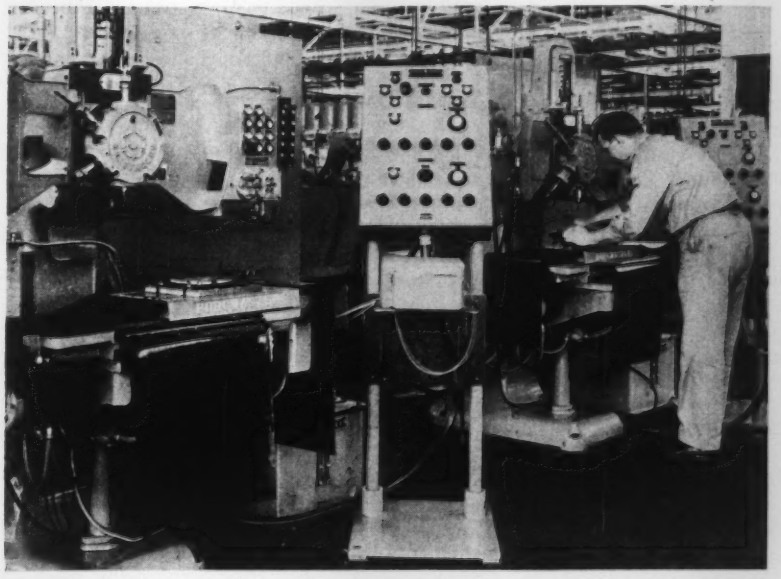
In the manufacture of aircraft engine parts such as jet engine fuel regulators, carburetors, and fuel pumps, tooling can be completed in one-sixth the time formerly required for manually controlled drilling machines. In the old equipment, complex fixtures were required to hold work steady and in an accurate position. In addition to being costly, these fixtures often took months to design and construct. With the numerically controlled machines, only a simple, flat plate with two pin holes is required to secure the work to the positioning table.

For example, designing, building a fixture, and tooling for one particular part cost approximately $20,000 when manually controlled machines were used. With numerically controlled machines, the same tooling can be done for $2000. All of the company's savings have not been of this magnitude, but the over-all reduction in tooling costs amounts to about 40 per cent.

Downtime for design changes during production has also been reduced due to the numerically controlled machines. Instead of having to build a new fixture, the changes can be incorporated by splicing a new piece of tape into the existing tape. Extensive production changes can be made by programming a new tape.

Other factors in favor of the numerically controlled machines are that only two days are required to train an operator to handle the units, and one man can easily operate both drills. The repetitive accuracy of the automatic control system and the elimination of the human-error factor have cut scrap losses to almost zero. Since the company is producing government work, part fixtures have to be stored for several years in the event that additional parts are needed at a later date. Storage problems created by the bulky fixtures used on the manually operated machines have been eliminated since only a small spool of tape and a locating plate have to be stored.

The turret drills were manufactured by Burg Tool Mfg. Co. and are operated by numerical positioning control systems designed and built by the Specialty Control Dept., General Electric Co. Before installing the new machines, Chandler Evans found it difficult to compete with specialty job shops on small lot orders of 50 to 100 parts. Today, with preproduction costs reduced significantly, the company is able to bid competitively on both small and large lot orders.



Operator positions a workpiece on the table of one of the two numerically controlled turret drills recently installed at Chandler Evans Corp. Automatic control of the drilling units provides longer tool life by operating each drill at its optimum feed rate and rotational speed. On the table of the machine at the left can be seen a simple positioning plate for holding the work. The numerical control system eliminates the necessity for complex and expensive work holding fixtures.

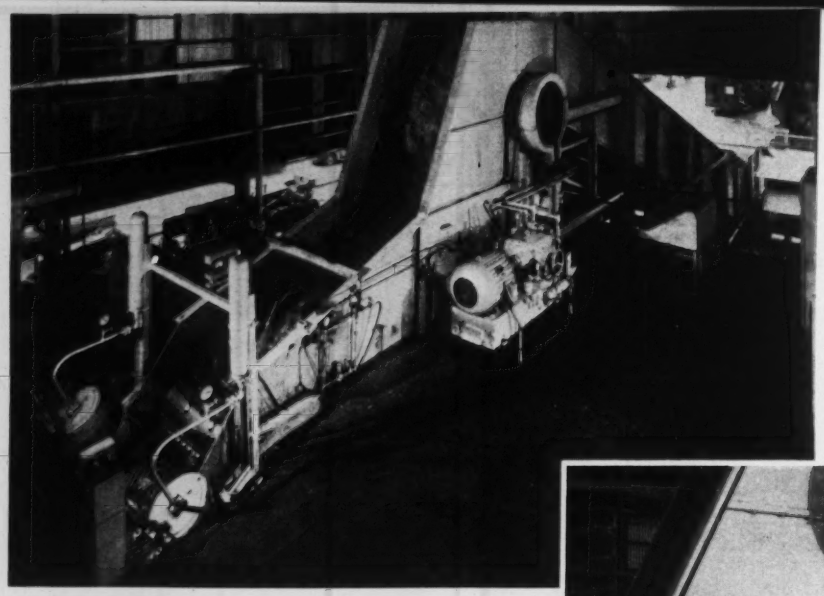
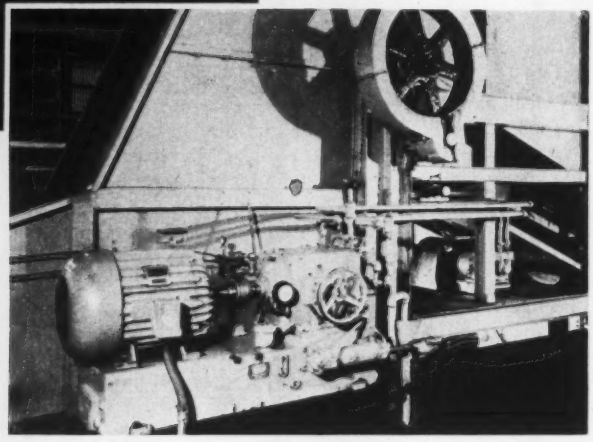


Fig. 1—In operation of this processing unit, long stalks of sugar cane are loaded onto inclined conveyor at street level and transported to a cutting station. After cutting, small pieces are elevated and dropped onto second conveyor leading to milling unit at left. Inset shows variable speed hydraulic drive for inclined conveyor.



SPEED CONTROLS AUTOMATE

SUGAR CANE PROCESSING

COMMERCIAL establishments engaged in processing food items immediately after they are harvested are often faced with manufacturing problems that are not found, or are easily controlled, in other industries. For example, in such food processing activities, raw materials usually arrive from the fields at irregular intervals and in varying quantities. Stockpiling of supplies for extended lengths of time is impossible, of course, because of the perishable nature of the product. Therefore, at peak harvest times, high processing rates conducted around the clock may be involved.

Nonuniformity of material size, and differences in handling characteristics due to varying quality or degree of maturity, may also introduce problems. Some food items are naturally difficult to handle because of a tendency to bunch or pile up during processing. Finally, maintenance of a high level of sanitation is an absolute necessity in food processing operations.

All of these considerations were faced by engineers at Central Igualdad, Mayaguez, P. R., in the design of equipment, *Fig.* 1, for carrying out certain sugar cane processing operations. In terms of actual specifications, the equipment had to perform reliably at high operating speeds, be adaptable to varying input rates and material characteristics, contain inherent protection from overloads, and be easy to clean.

System Operation

In operation of the system, *Fig.* 2, long stalks of harvested sugar cane, unloaded from trucks or railroad cars, are placed at the input end of an inclined, metal slat-type conveyor. The conveyor transports the stalks to a cutting station—which includes two motor driven, multibladed cutters arranged in tandem—where the stalks are cut into small pieces. After they leave the cutting station, the small pieces are elevated by the inclined conveyor and dropped onto a second conveyor. The second conveyor is driven at a constant speed by the mill, and serves to feed the cut material to a first milling unit where juice extraction begins.

Special problems encountered in operation of the system include: 1. Maintaining optimum flow of cut cane to the second conveyor to keep the mill operating at maximum capacity. 2. Quickly stop-

ping the flow of material to the second conveyor when the feed backs up because of bunching at the milling unit. 3. Keeping the input conveyor operating at maximum capacity without overloading the electric motors driving the cutters. (Overloading of the motors can occur because of intermittent introduction of large batches of material to the system; physical characteristics of the material that require added power to effect cutting; and dulling of the cutter blades.)

▶ Automatic Controls

To overcome these production problems, the first conveyor was equipped with a variable speed drive using Oilgear Co. hydraulic components. Automatic controls were then added to make the drive speed responsive to required feed rates, with overriding protection against system overloads. Actions of the automatic controls under different operating conditions may be followed by reference to the simplified schematic diagram of *Fig.* 2.

Ideally, the feed rate of raw cane to the cutter station should load the cutter motors to about 90 per cent of their ratings. However, in actual operation, the cutters are sometimes underloaded and at other times overloaded. To take care of these situations, motor current relays automatically call for maximum conveyor speed when the motors are underloaded, and either slow or stop the conveyor when overloads occur.

Slowing or stopping of the first conveyor in response to cutter motor overloads is effected with a combination of electrical and pneumatic control elements. These include current transformers, relays, and electropneumatic transducers. Control actions are as follows:

A current transformer for each cutter motor continuously senses the load condition on that motor and transmits an electrical signal to a current relay. For motor loads up to 90 per cent, no speed limiting action is initiated. However, as the load increases above 90 per cent, the current relay actuates an electropneumatic transducer so that a pneumatic signal is generated calling for slowing of the conveyor. This signal enters the pressure selector and, if it represents a command for a lower speed than any other input present, is routed to the recorder controller. The result is a slowing of the first conveyor by the amount needed to reduce the cutter motor load to 90 per cent. If the overload on a cutter motor is excessive, the current relay for that motor will actuate the solenoid of the bypass valve and the conveyor will stop.

Since the second conveyor is operated at a constant speed, measurement of the depth of material is an index of the material feed rate to the mill. Sensing of depth is accomplished with a feeler plate on the second conveyor. As the depth of material varies, the feeler plate assumes different angles about a pivot. This action, in turn, operates a pneumatic transducer that generates air signals indicating material depth.

The signals from the pneumatic transducer enter the pressure selector and, in the absence of signals calling for lower speeds, are routed to a pneumatic recorder controller. Output of the recorder controller operates a pneumatic actuator on a variable displacement pump. Positioning of the actuator, in response to 3 to 15 psi air signals from the recorder controller, determines the output of the pump and hence the drive speed for the first conveyor. In this manner the speed of the first conveyor is continuously adjusted to maintain a predetermined, constant rate of feed to the second conveyor and the mill. If no material, or too little material, is available on the first conveyor, the speed of this unit will be held to a preset maximum by the recorder controller. Also, if the depth of material on the second conveyor becomes too great because of material pile-up, the feeler plate will reach a maximum displacement and actuate a limit switch. Actuation of the limit switch will then energize the solenoid of a bypass valve in the hydraulic line from the pump to the motor, and the first conveyor will be stopped until the jam on the second conveyor is cleared.

Other control features include provision for manual starting, inching, accelerating, decelerating, and stopping of the first conveyor to suit process needs or unusual conditions.

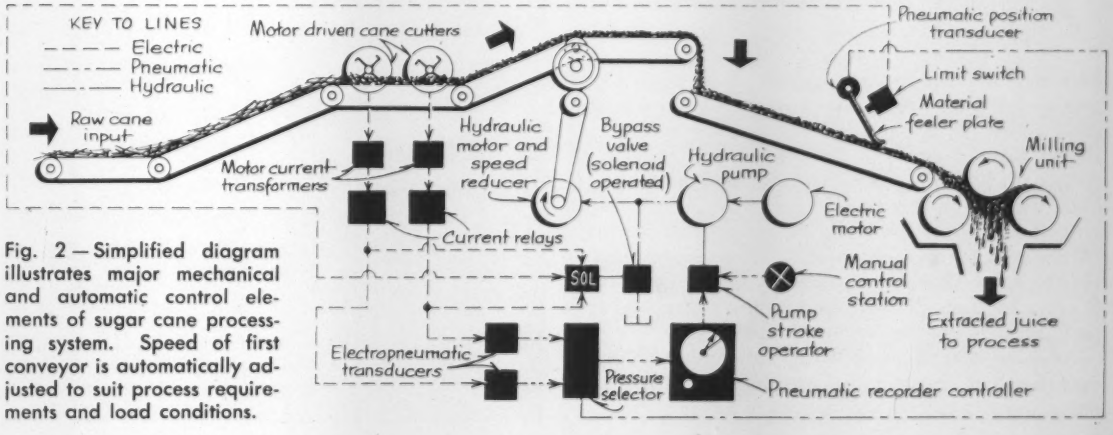


Fig. 2 — Simplified diagram illustrates major mechanical and automatic control elements of sugar cane processing system. Speed of first conveyor is automatically adjusted to suit process requirements and load conditions.

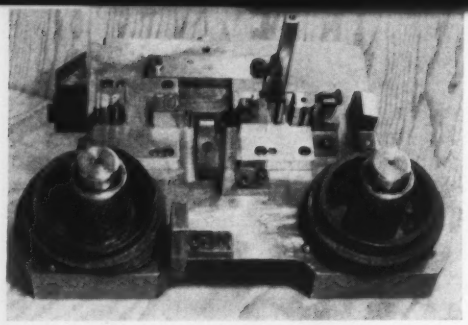
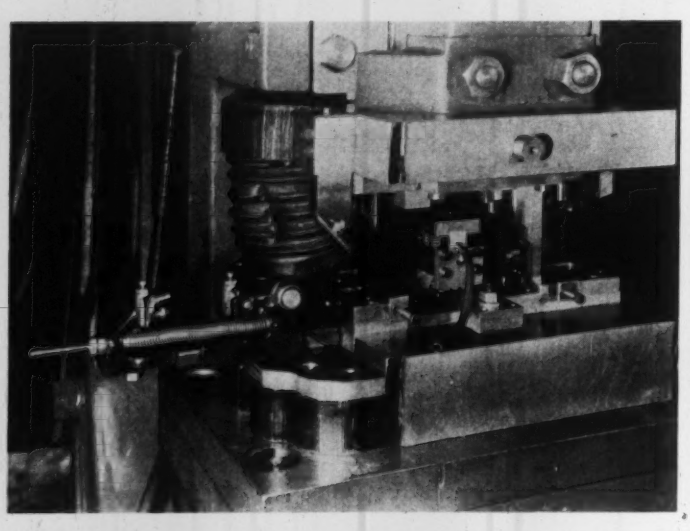
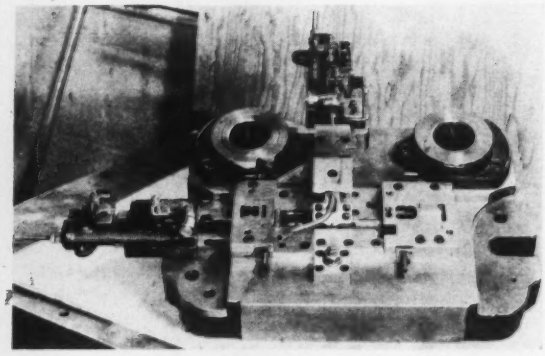


Fig. 1—Progressive die set has eleven stations for the manufacture and assembly of three parts into small shoe buckles. Strip stock for the frame of the buckle is hitch fed from the left of the die set, other strip stock for the roller is hitch fed from the rear of the die set, and wire stock for the tongue of the buckle is roll fed from below the die. Piercing, coining, blanking, and assembly tools can be seen in views of the upper and lower die halves.



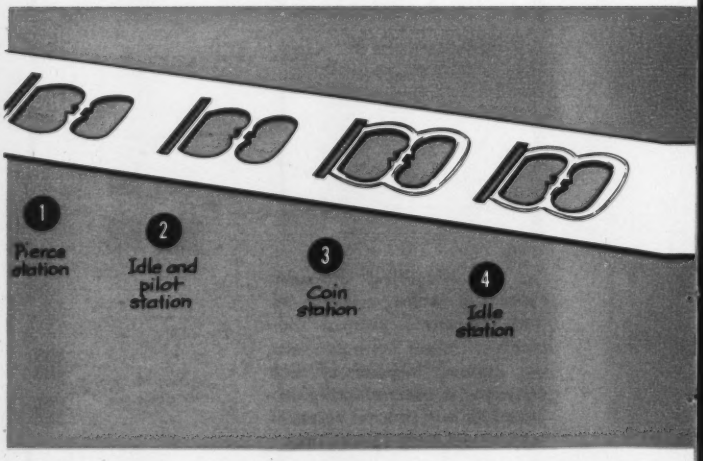


FROM COIL STOCK TO SHOE BUCKLE . . .

PRESS MAKES THREE-PART ASSEMBLY

COMMON work performing operations assigned to metalworking presses include blanking, piercing, notching, trimming, forming, drawing, and coining. In setting up a production process for press operations, a basic technique commonly used is to blank on one press, pierce on a second press, form on a third press, and trim on a fourth press. This process can be mechanized to a high degree by connecting press operations with automatic material handling devices so that manual handling of parts is not required between operations. However, considerable investment in machine tools is required if single work performing operations are performed on a series of individual presses.

Another method of applying automation to press operations at considerably less investment in machine tools is to combine two or more press opera-



Many small assemblies can be produced on a single machine by using a multistation die set. This combination is in reality a miniature automated production line. In the system described, a progressive die in only one press is used to manufacture and assemble three parts for small shoe buckles at rates up to 175 units per minute.

tions on a single press by using a progressive die. In this setup, automation is attained by progressively feeding strip stock through a series of stations in a multiple-tooled die so that for each press stroke a different work performing operation is performed on the advancing strip. For example, the first station in the die set may pierce the strip. On the next press stroke the strip can be advanced under a second tool which may coin the pierced strip. The third press stroke can again advance the strip and may blank the part out of the strip. Depending upon the size and material of the part, these three operations may be done simultaneously on three parts or a single part may be progressively advanced and worked on by a single tool for each press stroke.

Usually, as the size of the part decreases, the number of stations that can be incorporated in a progressive die set increases. In effect, some intricate progressive die sets are complete automated production lines in miniature. For example, a progressive die set, *Fig.* 1, designed and built by Progressive Tool Co. combines piercing, coining, and blanking operations on one part with separate forming and assembly operations on two other parts to make miniature shoe buckles on one press. These buckles measure approximately 3/4 inch in length by 9/16 inch in width and each one incorporates three separate parts—a frame, a roller, and a tongue—which are all manufactured from coil stock and assembled in the single progressive die set.

The progressive die set employs eleven stations, *Fig.* 2, in transforming strip stock into assembled buckles. The frame stock is fed from a stock reel and is indexed from station to station by a hitch feed device actuated by a cam and roller on each stroke of the press. At the first station of the die, three punches simultaneously pierce the frame stock and cut out a rectangular slot and two perforations in the frame strip. On the upstroke of the press, the hitch feed indexes the strip to the second station which contains a pilot blade to accurately center the strip for the coining operation at the third station. On the downstroke of the press, the pilot blade enters the rectangular slot pierced in the frame strip and holds the strip as the buckle shape is coined on top and bottom of the strip at the third station.

The fourth station is an idle station to allow the space necessary to mount the roller forming and assembly device at the fifth station in the die. As shown in *Fig.* 3, the roller is formed from a sepa-

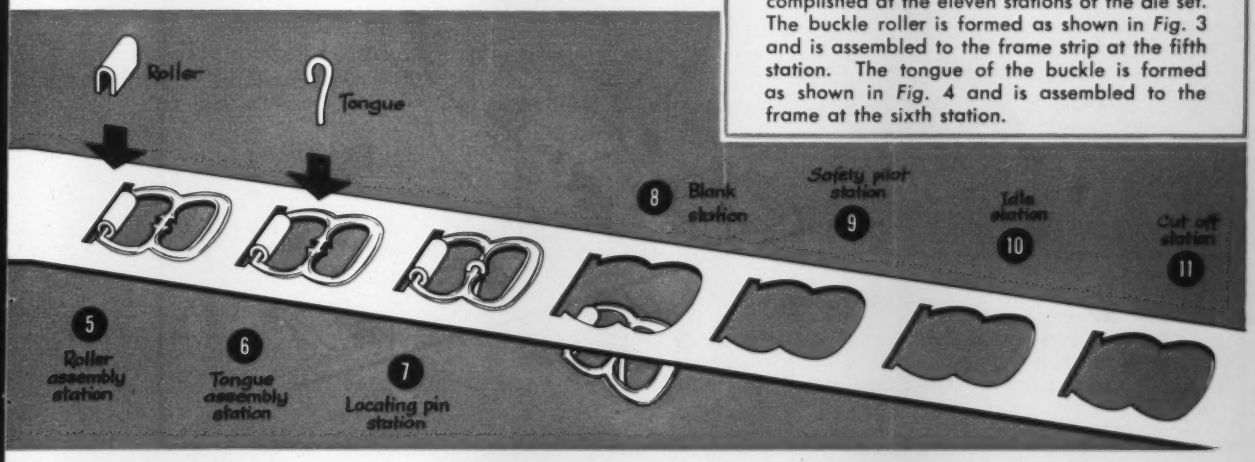


Fig. 2—During each press downstroke, the various piercing, coining, blanking, cutoff, and assembly tools simultaneously perform work on the frame strip, roller strip, and tongue wire. This diagram shows the various operations accomplished at the eleven stations of the die set. The buckle roller is formed as shown in *Fig.* 3 and is assembled to the frame strip at the fifth station. The tongue of the buckle is formed as shown in *Fig.* 4 and is assembled to the frame at the sixth station.

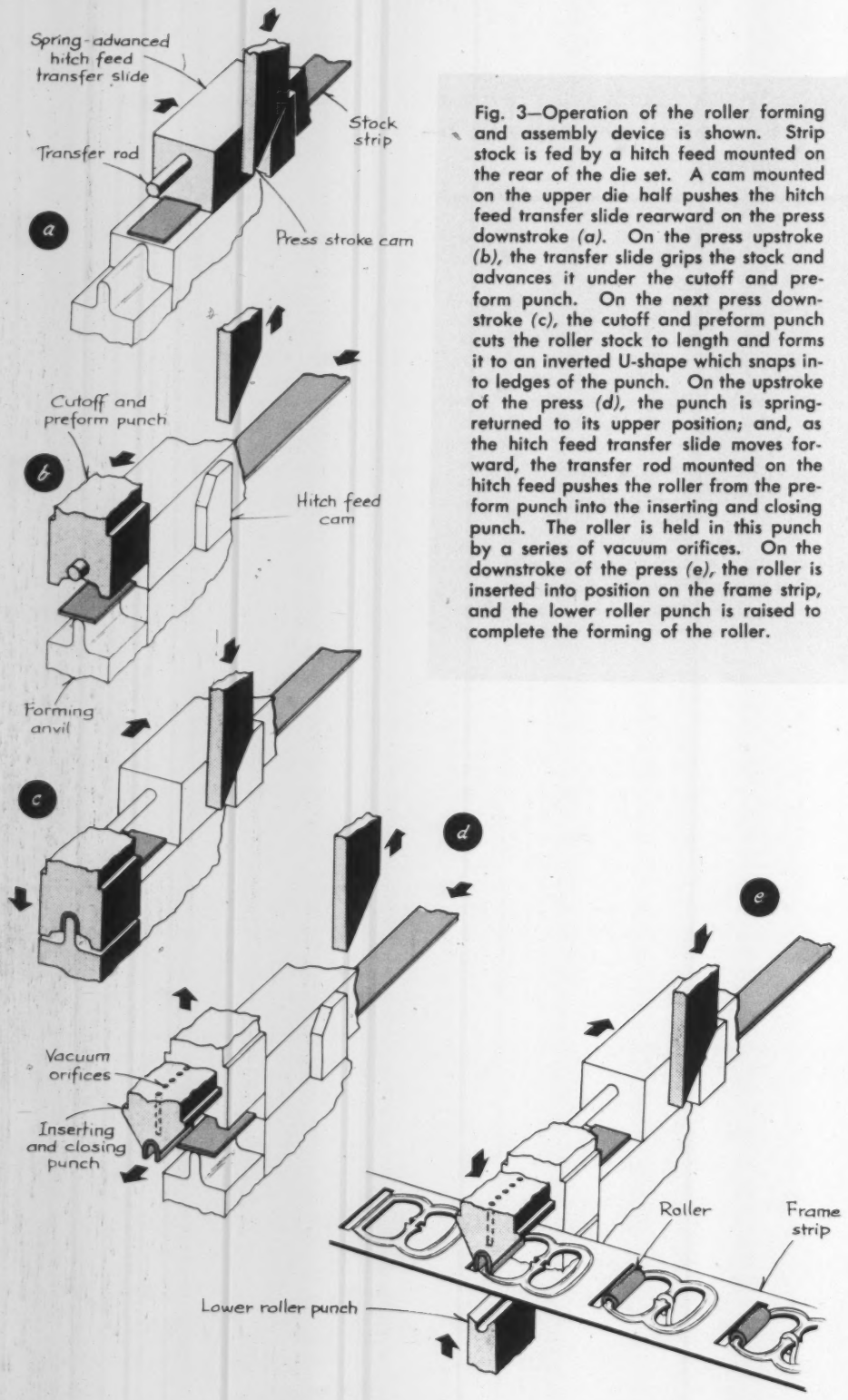


Fig. 3—Operation of the roller forming and assembly device is shown. Strip stock is fed by a hitch feed mounted on the rear of the die set. A cam mounted on the upper die half pushes the hitch feed transfer slide rearward on the press downstroke *(a)*. On the press upstroke *(b)*, the transfer slide grips the stock and advances it under the cutoff and preform punch. On the next press downstroke *(c)*, the cutoff and preform punch cuts the roller stock to length and forms it to an inverted U-shape which snaps into ledges of the punch. On the upstroke of the press *(d)*, the punch is spring-returned to its upper position; and, as the hitch feed transfer slide moves forward, the transfer rod mounted on the hitch feed pushes the roller from the preform punch into the inserting and closing punch. The roller is held in this punch by a series of vacuum orifices. On the downstroke of the press *(e)*, the roller is inserted into position on the frame strip, and the lower roller punch is raised to complete the forming of the roller.

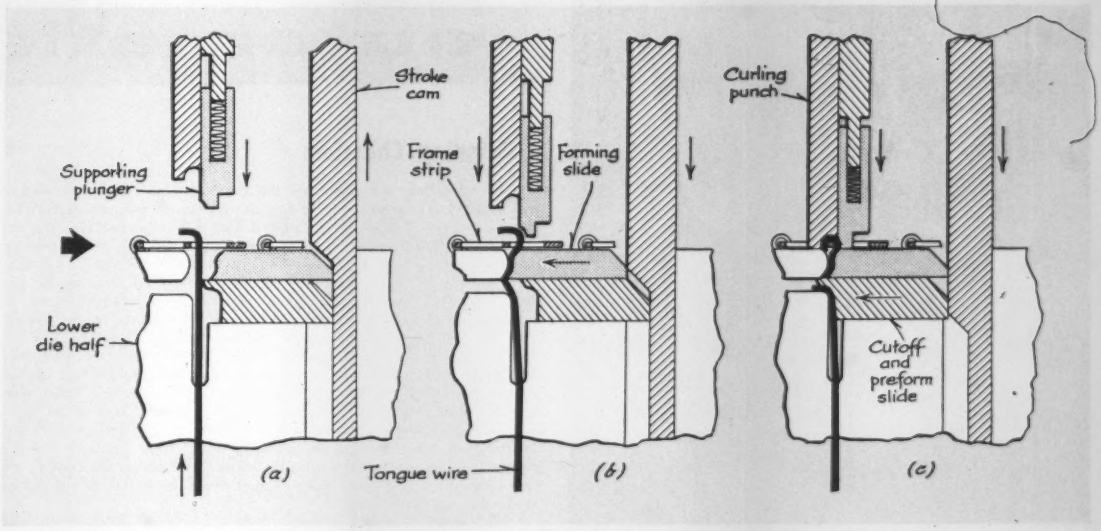


Fig. 4—Operation of the tongue forming and assembly device at the sixth station is shown. On the upstroke of the press *(a)*, the frame strip indexes a buckle cutout into the station. At the same time the preformed tongue wire is roll fed vertically past the retracted forming and cutoff slides and into the opening in the frame strip. On the downstroke of the press *(b)*, the stroke cam moves the forming slide against the tongue wire, and then moves the cutoff and preform slide to cut the wire and preform a bend in the wire for the next tongue *(c)*. During this operation, the supporting plunger orients and holds the tongue as the curling punch completes the closure of the wire on the frame.

rate strip that is hitch fed from the rear of the die set. In a series of automatic operations, the strip is cut off and preformed to an inverted U-shape on a downstroke of the press, transferred horizontally to an inserting and closing punch by the hitch feed transfer slide on the upstroke of the press, and positioned and closed on the frame on the next press downstroke.

At the sixth station, *Fig.* 4, a 1/16-inch diameter wire is fed from below the die through the buckle. In a second series of automatic operations, the tongue is formed, cut off, and secured on the buckle. The frame strip, which now contains the assembled roller and tongue, is next indexed to an idle position at the seventh station and then to a blanking die at the eighth station. At this point the completed buckle is blanked from the frame strip and drops into a collection box below the die. The blanking die has a shear surface so that the buckle is bent approximately 30 degrees around an axis through the eye of the tongue. To hold the frame strip in proper alignment for the blanking die, a pair of locating pins enter the buckle cutout at the seventh station and a safety pilot device enters the previously blanked hole at the ninth station. The scrap frame strip is then indexed to an idle position at the tenth station and is shear cut into small pieces at the eleventh station.

The unique progressive die set was developed for a buckle manufacturer who produces more than 72 million buckles each year. Prior to the development of the progressive die set, the parts were made individually on presses and were assembled in kick presses by approximately 30 operators. The progressive die set installed in an open back inclinable press produces from 125 to 175 complete buckles per minute, and all of the yearly production can be made by six to eight operators.

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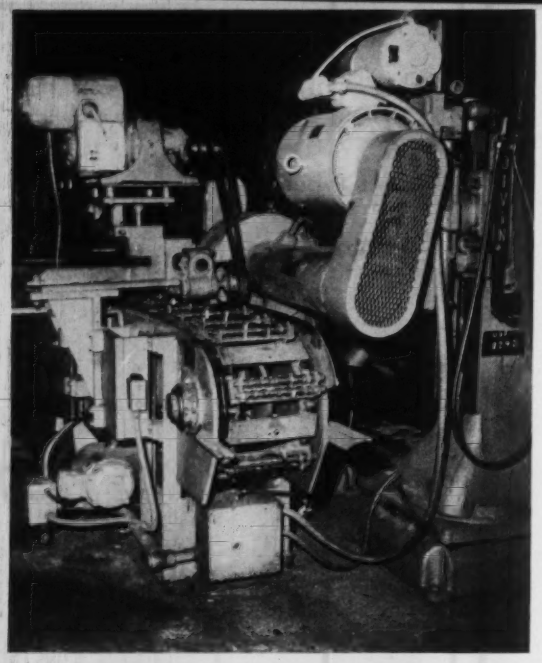


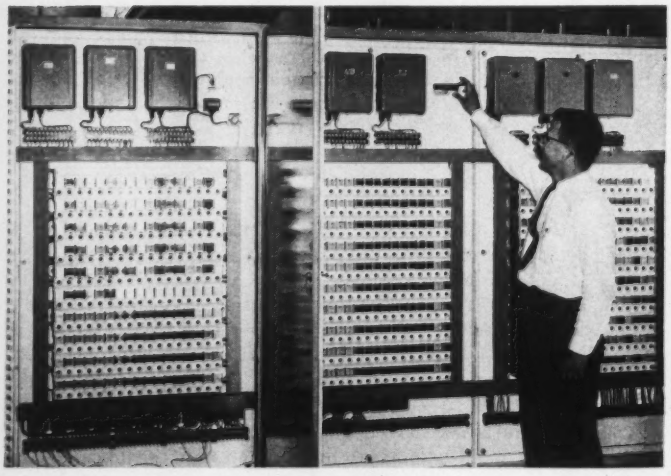
automation

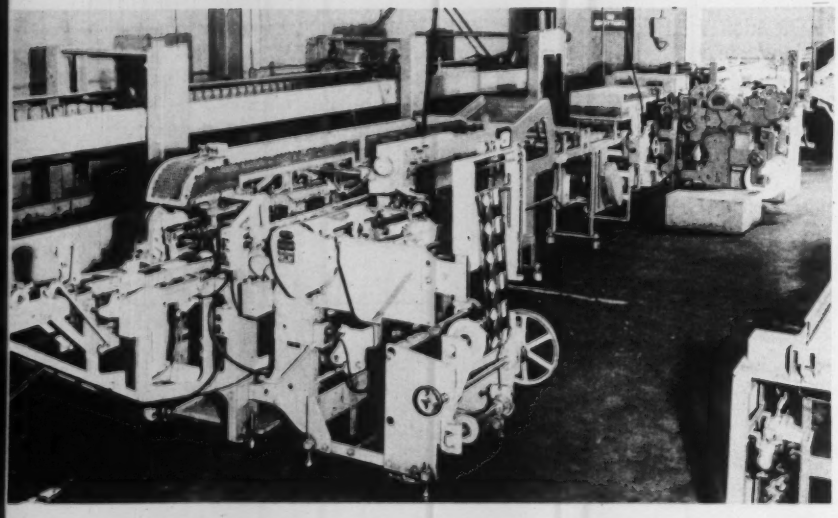
Grinding Chamfers

MINOR operations are sometimes the key to the successful manufacture of critical products. For example, in the manufacture of precision turbine blades for jet aircraft at Utica Drop-Forge & Tool Div., Kelsey-Hayes Co., metal alloy for the blades is received in the form of rods which are then cut in dimensional sizes ranging from 6 to 18 inches. Each rod is heated and upset on one end to form a blob of metal which will become the root of the blade after forging. In order to form this blob properly, it was found necessary to grind a 45-degree chamfer on the rod end to be heated. At first, this grinding job was done manually using a grinding wheel, and output per man was approximately 360 rods per hour. The operation was later mechanized by installing a Divine Bros. Co. straight line production grinder shown in the photograph. A continuous conveyor fitted with 38 fixtures moves the rods past three grinding wheels, two of 36 grit and one of 46 grit. In each fixture, a rod is placed on two sets of nylon rollers. As the rods move toward the grinding wheels, an overhead belt system pushes the rods against the abrasive wheels and causes the rods to rotate. One man can operate the machine and attain an output of approximately 1140 units per hour.

Controlling Parts Flow

CONTROL panel, designed and built by the Detroit Service Shop of General Electric Co., is used in a mid-western automotive plant to regulate the sorting, counting, storage, and release of eight different kinds of automobile instrument clusters. All components for the clusters are made, tested, and assembled on four parallel production lines. The completed instrument clusters are conveyed in random order to a control station where they are counted and routed to one of 16 temporary storage conveyors on two levels. When sufficient units accumulate on a storage conveyor to make one pallet load, the control panel discharges the lot to the shipping area. The panel uses more than 500 static switching and memory elements to control 16 conveyors with 24 motor stations and 9 power sources. It counts and records each action and decision, and it automatically adjusts the tally-and-discharge function of each storage conveyor according to its contents' type and size.





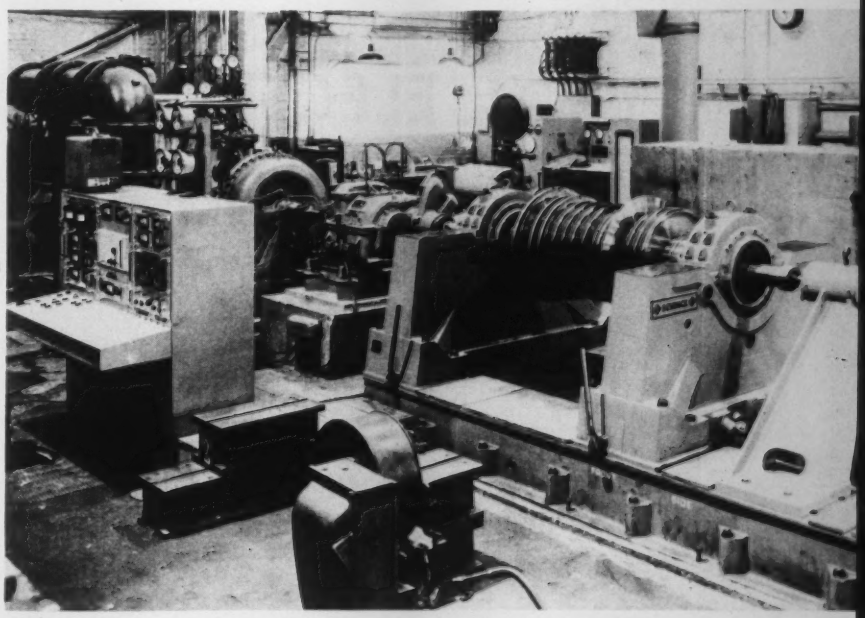
Packaging Tape

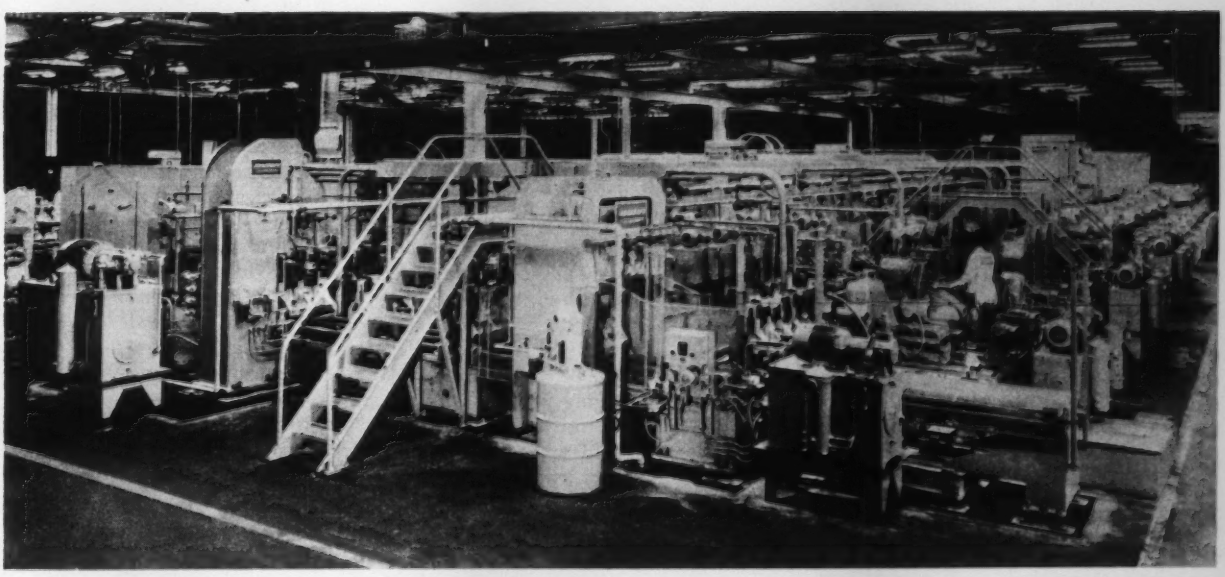
INTEGRATED packaging line at a Minnesota Mining and Mfg. Co. plant in Bristol, Pa., wraps individual rolls of ½, ⅜, and ¾-inch wide cellophane tape in printed foil and then accumulates and bundles 12 rolls into a shipping package with a second overwrap. In prior operations, the tape is wound on cores and placed in boxes measuring either 3 x 3 x ⅝ inch or 3 x 3 x ⅞ inch, depending upon tape width. Lying in a flat position, the sealed boxes of tape are conveyed into the first wrapping machine in the left foreground where each box is overwrapped with a preprinted foil. As the individual boxes move toward the bundling machine in the right background, they are turned on end and accumulated in six channels to form the bundling unit. Two rows of six boxes each are then released into the bundler where a second preprinted material is overwrapped around the 12-roll shipping unit. The packaging machines were provided by Battle Creek Packaging Machines Inc.

in action

Balancing Turbine Spindles

HIGH-SPEED dynamic balancing machine installed at De Laval Steam Turbine Co. is capable of accommodating units weighing from 200 to 14,000 pounds and balancing at speeds from 1000 to 12,000 rpm. The machine is sensitive to bearing vibrations in the order of 0.000004-inch displacement of center of gravity. For example, the machine can detect an unbalance as small as one gram at a 10-inch distance from the axis of rotation on a 5500-pound rotor spinning at 4000 rpm. Unbalance is indicated both graphically and numerically on the control panel at the left of the picture. The display also indicates automatically where weight should be added or removed to bring a rotating component into near-perfect balance. Built by Carl Schenck, Darmstadt, the machine provides a high degree of precision since it can automatically balance high speed rotors at or near their eventual operating speeds.





Machining Pump Housings

SEVENTY-SIX station transfer machine, designed and built by Buhr Machine Tool Co., performs 220 operations on hydraulic pump housings at Saginaw Steering Gear Div., General Motors Corp. Two housings are manually loaded and then automatically located and clamped in each fixture-pallet. During the closed-loop circuit in the 117-foot long machine, the various surfaces of the parts are milled and holes are drilled, reamed, spot-faced, counterbored, chamfered, and tapped. At one station, a babbitt bushing is correctly oriented with respect to a pump-shaft hole and is then pressed home. At another station, an air gage checks the pump-plunger hole for size and roundness, and a nozzle automatically sprays one of three paint colors on the housing to indicate the relation of the gage reading to the specified tolerance range. Immediately prior to the unload station, the fixture clamp is automatically backed off and rotated 90 degrees so that the operator can easily unload the parts. Automatic in-process checking is done at various stations by 12 probes to ensure that holes have been drilled, and 13 drill checks are made to monitor the condition of other drills.

Fig. 1—Basic transducer in a Sheffield electropneumatic system can be set to respond to pneumatic pressure changes as small as 0.05 psi. Operating in range of 5 to 25 psi, unit can actuate signal lights or relays through electrical contacts that operate when a preset pressure is sensed.

ELECTROPNEUMATIC GAGING AND CONTROL

Much of automation's progress has been based on the skillful combining of different techniques. Highlighting this element in improved industrial operations are electropneumatic systems in which well-established pneumatic measuring techniques have been combined with electrical techniques to provide control in a variety of automatic applications.

By **LOUIS F. POLK, JR.**, Assistant Vice President and Manager, Instruments and Systems Div., Sheffield Corp., Dayton, Ohio

IMPORTANT as they are to manufacturing progress, accurate dimensional standards would be but laboratory curiosities without convenient means to apply them on the production floor. For production dimensional gaging, "convenient means" traditionally embraces such factors as versatility, instantaneous and accurate readings, ease of setup and operation, and economy of operation. Within recent years, "convenient means" has been expanded to include the concept of automatic measurement, wherein measuring equipment not only senses the magnitudes of variables but also supplies necessary control signals to guide dependent production equipment.

One of the fastest growing areas in this form of automatic control involves electropneumatic systems in which pneumatic gaging units are provided with the means of translating sensed information into electrical actuating signals.

A basic pneumatic gaging system consists essentially of components that provide a constant pressure air supply, indicating means, and a metering orifice. The principle of operation is based upon the effects of varying the flow of air from the metering orifice. For example, as flow from the orifice is obstructed, pressure in the system will build up to the regulated value and flow throughout the system will fall off. Over a significant range of values in such a gaging system, there exists a linear relationship between flow or pressure and the size of the escapement orifice. In the more popular gaging applications, this linear relationship is equated to the clearance that separates a sized metering orifice and an obstruction. The indicating component reflects the change in flow or pressure as a linear measurement.

It should be noted that the obstruction can be either the workpiece being gaged or an integral part of the gage spindle. An example of the first would be found in the gaging of a bore by inserting a gaging spindle containing two diametrically opposed orifices through which air is flowing. In this type of application there is no contact between the gaging spindle and the part being measured; the closeness of fit serves as the obstruction. In the second type, the gage spindle includes a component that mechanically contacts the work being measured. Movement of this component relative to a sized orifice affects air flow and establishes the basis for measurements.

In practice, the pneumatic gage is used as a comparator, i.e. it measures variables by magnifying the difference in size between a standard and the work being measured. In flow measuring systems, changes in air flow are indicated by the position of a float in an internally-tapered glass tube through which the flow can be directed. Amplification is par-

tially a function of the taper within the tube and the amount of total available flow that passes through the tube. In pressure measuring systems, changes in pressure are indicated by well-established principles, such as a pointer actuated by bellows or a Bourdon tube. Amplification is obtained by pneumatic and mechanical means.

The usefulness of pneumatic gaging is attested to by the variety and types of measurements which can be made with the units. Basic applications are shown in TABLE 1. Industrial installations range from the simple application of a single gaging spindle to check a single dimension to multiple sensing applications in which, for example, as many as 40 dimensions are checked simultaneously. Obviously suited to post-process gaging in which parts are checked against specifications after machining, pneumatic units have also been applied to in-process gaging. An example would be a grinding operation in which a gaging head continuously monitors the work or movement of a machine member while work is being processed. The position of the float or dial indicator guides the operator, permitting him to grind to within exact tolerances without frequent stopping to check dimensions.

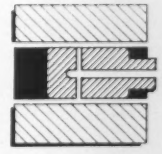
Electropneumatic Gages

It is upon this background that automatic installations involving electropneumatic components have been designed—the basic element in such systems being an air-to-electric transducer. In systems designed by the Sheffield Corp., the transducer, *Fig.* 1, is a pressure sensing, limit-type unit which can actuate signal lights or relays by making or breaking either of two independently adjustable contacts. Basically, then, the transducer is a sensitive pressure switch with two sets of contacts that can provide a signal upon sensing either of two desired pressure values.

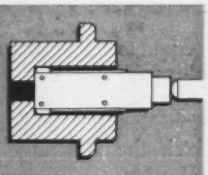
The Sheffield transducer operates in the pressure

TABLE 1

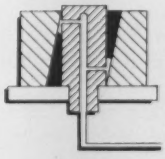
Conditions that can be checked with basic tooling.



Two diametrically opposed open jets check true diameter of holes having tolerances of 0.005 inch or less.

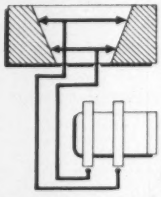


Contact-type gaging head is used in measuring diameters for interrupted bores and bores having a keyway.

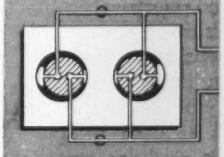


Spindle with opposed open orifices spaced longitudinally checks squareness of a bore axis with a face.

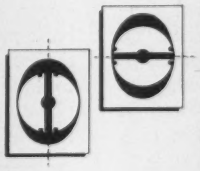
Camber or straightness of hole is checked by rotating through 180 degrees a spindle having four jets.



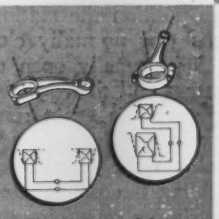
Taper is indicated as any spindle is passed through a bore.



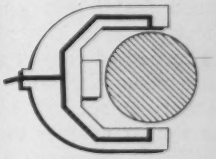
Center distance between holes can be checked by a fixture with two spindles, each having two opposed jets.



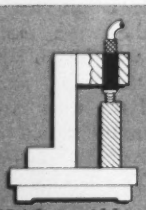
Out-of-round is indicated when any spindle is rotated through 90 degrees.



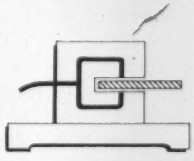
Parallelism of holes can be indicated by combining two spindles of type used in squareness checking.



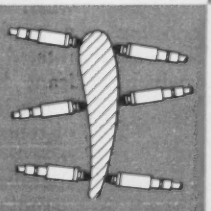
Outside diameter can be checked by two opposed standard jets; tolerance should be 0.002 inch or less.



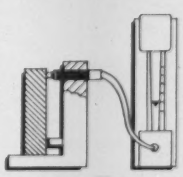
Height, width, or depth can be measured by a suitably fixtured contact type gaging head.



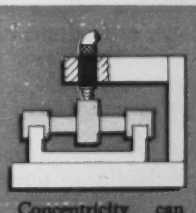
Thickness gage for thin parts and items having close tolerance incorporates two opposed standard jets.



Multiple contact type gage heads mounted in a suitable fixture can check contour.



Squareness of surfaces for close tolerance parts having good surface finish can be checked by a fixtured spindle.



Concentricity can be indicated by one or more contact-type spindles mounted in a suitable gage fixture.

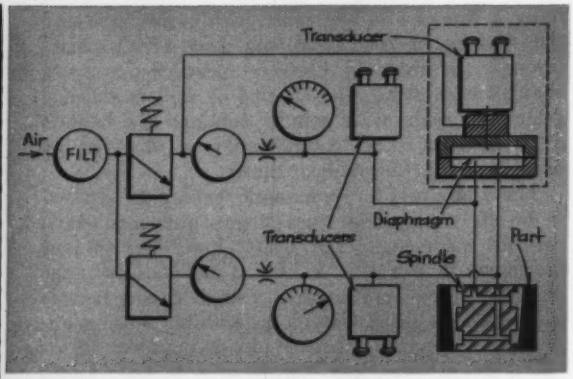


Fig. 2—For applications where a differential measurement is desired, basic transducer has been incorporated into a modular unit. As shown by the diagram, back pressures from two identical circuits are directed to either side of a diaphragm. Deflection of the diaphragm represents a difference between two measurements. The deflection of the diaphragm is sensed by the transducer.

range of 5-25 psi, responding to pressure changes as small as 0.05 psi. Accuracy and repeatability are within 1 per cent of the normal gage span. A transducer includes two bellows with linear expansion characteristics for the pressure range at which the component normally operates. In an application, contact operating adjustments for the two pairs of contacts are made with the aid of standardized limit gages or an indicating gage. In effect, the pressure at which a given contact pair is to operate is created in the system; this positions one contact which rests against a bellows. An adjusting knob is then manipulated to position the mating contact such that it just opens (for normally closed contacts) or just closes (for normally open contacts). The desired contact action will then be obtained in use when the same pressure is again sensed. The other contact pair of the transducer is adjusted in a similar manner to obtain the desired action at a different pressure, enabling the single transducer to respond to either a maximum or minimum pressure when sensed.

More than one air-to-electric transducer can be used in a single circuit. For example, in addition to one unit that indicates maximum and minimum values, a second unit can be connected in the circuit and adjusted to indicate pressures just below the maximum and above the minimum. Such an application could serve as a warning as to which, and when, critical limits are being approached.

▶ Modular Components

In addition to being used as an independent control unit, the basic transducer is incorporated into the design of several modular gaging control components. One such component is the differential gaging head, *Fig.* 2. A differential measurment can be made of such things as taper, taper tolerance, squareness of face to bore, center distance, bend and twist, and parallelism. For pneumatic gaging in such applications, two identically balanced air circuits are established as the primary measuring means, each being directed to a separate measuring orifice. Back pressure circuits connect each measuring circuit to different sides of a diaphragm mounted in a cavity. Significant variations in the back pressure of the two circuits, indicating a defect, cause the diaphragm to deflect. This deflection is sensed by a secondary pneumatic measuring circuit connected to an air-to-electric transducer, and electrical contacts are actuated if the back pressure in the secondary circuit reaches preset limits. Separate transducers can also be connected to each primary circuit in a differential gaging application to check the specified dimension being measured at each orifice.

Another modular component employing the air-to-electric transducer is the variation gaging head, *Fig.* 3. The unit is used to measure a variation in size as opposed to identifying the actual size. Typical of such measurements are those to check for an out-of-round condition or concentricity. For instance, when a pneumatic gaging spindle is inserted into a workpiece and rotated (or the work can be rotated about the spindle) there will be no significant back pressure change if the work surface being inspected is truly round. If the work is out-of-round, however, the back pressure would vary over a range with limits determined by the extent that the work is out-of round. The design of the variation gage head enables it to identify the back pressure range in such an application. In the unique Sheffield unit this is accomplished primarily by capturing and retaining the maximum pressure sensed. The back pressure circuit from the gaging head is directed over two paths to both sides of

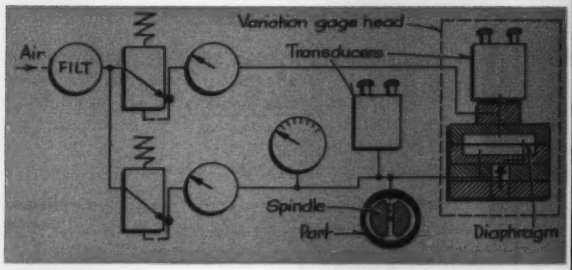


Fig. 3—Modular variation gage head is used to measure the extent to which a value varies in certain types of measurements. For instance, in measuring a hole for an out-of-round condition, the part might be rotated about a fixed air spindle. Variation in sensed air pressure would indicate an asymmetrical hole. Primary operation of modular gage head is to retain maximum pressure sensed and compare the sensing to minimum pressure sensed.

a diaphragm mounted in a cavity. One of the paths includes a small check valve that opposes flow from one side of the diaphragm cavity. As a gaging spindle is rotated, the maximum back pressure sensed is retained on that side of the diaphragm. With further spindle rotation the point of minimum back pressure is reached. This pressure is transmitted to only one side of the diaphragm and the diaphragm is deflected to an extreme point. A secondary pneumatic gaging circuit containing an air-to-electric transducer measures the deflection of the diaphragm and contacts are actuated if desired limits are exceeded. The primary measuring circuit in a variation gaging application can also contain a separate transducer to check the actual size of part being gaged.

In addition to the gaging spindles and transducers that have been discussed, a typical electro-pneumatic system involves such items as an air line filter, pressure regulator, pressure gage, metering restriction, setup dial, and a slave-relay unit.

Other modular components that include the basic transducer have been designed—primarily to provide various packaged combinations of the necessary and auxiliary devices associated with an installation, *Fig.* 4. For instance, one such package includes up to two transducers, the metering restriction, and the setup dial. Another package includes up to two transducers, the metering restriction, setup dial, pressure gage, and pressure regulator. This packaging technique protects the component parts of a system and provides users with a convenient, neat, and compact unit that can be incorporated into the design of a machine.

▶ Automatic Control

Combinations of the various basic gaging devices are used to provide signals and controls for a variety of applications. Some of these applications are: 1. Adjusting movement of cutting or forming tools. 2. Signaling replacement of worn tools. 3. Stopping machines. 4. Warning when part size trend approaches minimum or maximum limits. 5. Segregating parts at various stages of production. 6. Weighing and checking weight relationships. 7. Connecting or straightening parts automatically. 8. Matching parts for selective assembly. 9. Inspecting finished parts. 10. Classifying and matching parts. 11. Selectively packaging parts.

All of these uses are predicated upon a desired action taking place via electrical signals that are triggered, directly or indirectly, by size measurements obtained from pneumatic gages. And with the accurate creation of a signal, the pneumatic elements in the gaging system have done their job. There-

Fig. 4—Other modular components which include the basic air-electric transducer have been developed to provide users with convenient package of elements required in a system. Packages include such items as: metering restrictions, setup dials, pressure regulators, and pressure gages.

after the capabilities of the system are determined by electrical techniques and the sophistication of the circuit design and electrical gear in the system. Here the important thing to note is that the information obtained from limit-type pneumatic gaging can simultaneously serve to check the accuracy of an operation, control a machine, segregate parts into size categories, and initiate auxiliary control signals.

Some idea of the engineering details involved in obtaining an automatic installation are evidenced by *Fig.* 5. The illustrated electrical and pneumatic circuits provide for the relatively simple post-process inspection of the bore of a cylindrical part. With this system, good parts can be separated from rejects and the production machine can be stopped if a predetermined number of rejects are gaged. Salvable rejects might be separated from nonsalvable rejects. The machining trend can be followed, by keeping track of the number of parts approaching the reject limits, and the production equipment stopped at some predetermined phase of a trend. The physical appearance of the type of equipment is shown in *Fig.* 6. As a pedestal mounted, integrated gaging system, the equipment is readily incorporated directly into a production line. Inspection rates up to several thousand parts per hour are possible with the type of equipment indicated.

As the illustrated system is applied in an operation, parts from one or several machines roll in single file to the upper end of an inclined chute. A pneumatic cylinder escapement device allows one part at a time to be separated from the waiting file—and it rolls to a gaging point. Mounted on a slide and actuated by a pneumatic cylinder, the pneumatic gaging head is automatically inserted into the bore of the part to be inspected. As shown in the electrical diagram, these straightforward sequencing operations (which follow upon the presence of parts to be gaged) are modified by the action of time delay relays. For instance, a time delay relay must time out before the gaging spindle is inserted into the workpiece. This allows for part bounce that occurs as a part hits a stop at the gaging position after rolling down the chute. The time period during which the gaging spindle remains in the workpiece is also controlled by a time delay relay. An additional time delay relay is used to allow the workpiece to roll out of the gage station. These circuits, then, provide for sequential presentation of workpieces to a gaging station and cycling of the gaging head. The several control actions of which the equipment is capable are determined by the electropneumatic circuit and the sensing obtained by the pneumatic gage.

▶ The Gaging Circuit

Two air-electric transducers are used in the electropneumatic gaging circuit. These transducers are contained in a packaged control unit that includes four slave relays and an additional relay to interlock the control unit with the sequencing circuit. One of the transducers is set to provide reject signals

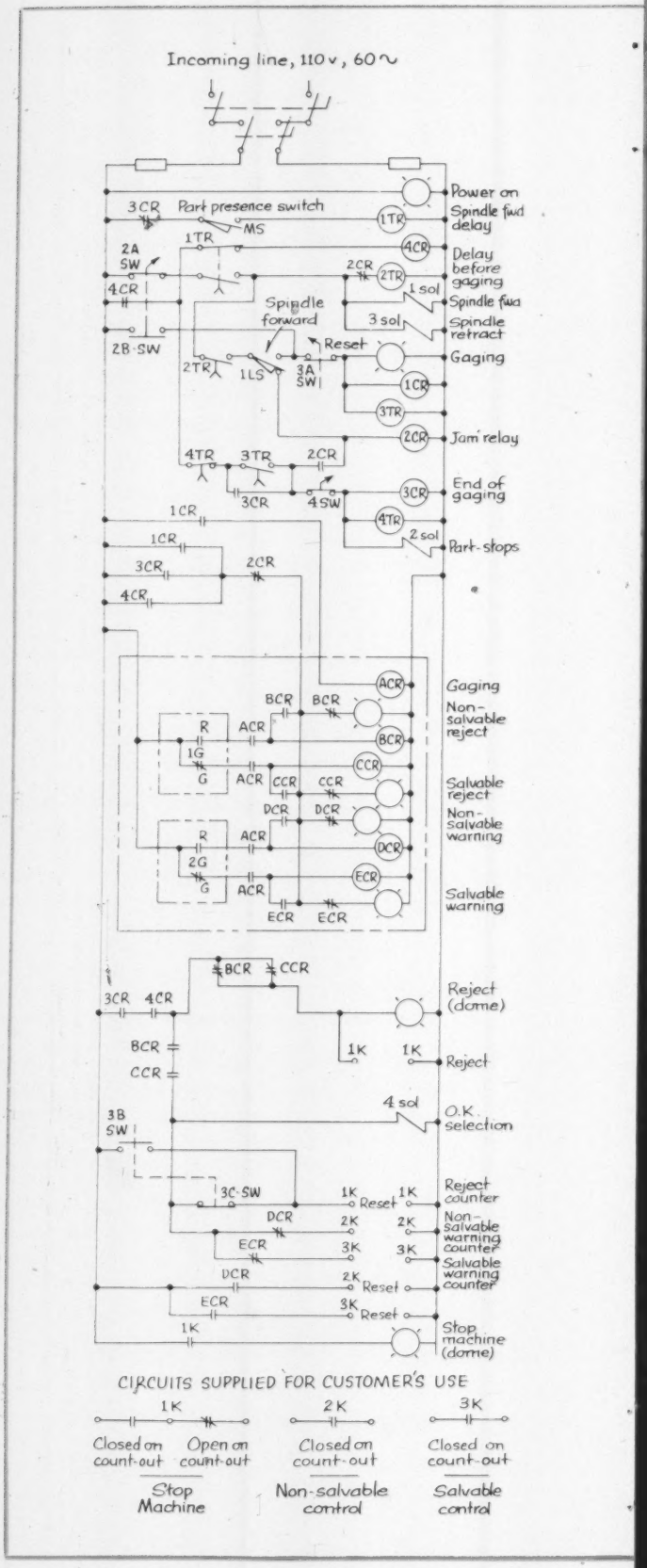


Fig. 5—Electrical and pneumatic circuit diagrams for machine that automatically inspects bores of small items. A picture of the machine is shown in Fig. 6.

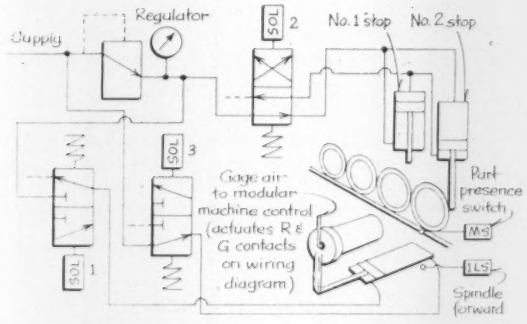
With electrical and pneumatic circuits as indicated, gaging cycle is commenced when part rolls down escapement, stopping at No. 2 Stop and actuating parts-presence switch *MS*. Time delay timer 1*TR* energizes and starts timing to allow for part bounce.

When 1*TR* times out: Control relay 4*CR* is de-energized and the gage-relay circuit drops out; 2*TR* is energized and starts timing for a delay in gaging; and 1*Sol* and 3*Sol* are energized to bring the gaging spindle forward.

When 2*TR* times out; 1*CR* energizes to initiate gaging and 3*TR* is energized to establish gaging time.

When 3*TR* times out: Relay 3*CR* energizes, dropping out 1*TR*, 2*TR*, 1*CR* and 3*TR* in succession; circuit to solenoids and counters is closed; No. 1 Stop moves forward; No. 2 Stop retracts; gaging spindle retracts; and 4*TR* is energized to allow time for part to roll out of gage station.

When 4*TR* times out: Relay 3*CR* is de-energized, opening the circuit to 4*TR*; solenoid and counter circuits are de-energized; No. 1 Stop retracts; and No. 2 Stop moves forward. When following part actuates *MS*, new gaging cycle begins.



Actions of gaging relay circuit follows from state of contacts *R* and *G* in gage heads 1*G* and 2*G*. Gage head 1*G* and associated relays *BCR* and *CCR* are concerned with acceptance or rejection. For acceptance, both *BCR* and *CCR* must operate each cycle. This requires that normally open contact *R* be closed and normally closed contact *G* remain closed.

Reject counter 1*K* is actuated each time a reject part is gaged; it will reset each time an acceptable part is gaged. Should 1*K* count to a predetermined number, the machine is stopped.

Gage head 2*G* and associated relays *DCR* and *ECR* are concerned with the trend of sensed meaurements. For a completely acceptable (O.K.) part, *DRC* and *ECR* must operate. This requires that normally open contact *R* be closed and that normally closed contact *G* remain closed.

Salvable or non-salvable warning count will register on counter 2*K* or 3*K* each time a part in the warning range is gaged. The warning counters will reset whenever an O.K. part is gaged or a warning part in the opposite range is gaged. Should either counter reach a predetermined count, a control or indicating signal is created.

through relay operations if a part is either over or under size. The second transducer is set to provide warning signals through relay operations at points approaching the reject limits.

Optional contacts available in the four slave relay circuits are interconnected with relay contacts in the sequencing circuit to obtain auxiliary actuating signals. Depending on the condition sensed by the pneumatic gaging head, the system passes in-tolerance parts and commences another gaging cycle—noting on separate parts counters if the accepted part is within the warning range for either the over or under size classification. When a predetermined number of parts of either warning classification are gaged, a control circuit can be energized to sound an alarm, to stop the production machine, or to make a predetermined incremental adjustment in the machine setting.

Out-of-tolerance parts can be separated from acceptable parts, and a reject counter actuated by means of the electrical control circuits to keep count of the rejects. The production equipment can be stopped when a predetermined number of rejects have been counted.

It is apparent that in a gaging system based upon limit-type gage sensing, counters play an important role in obtaining practical control of a quantity production system. Following statistical theory, the control scheme recognizes that the gaging of any one item can present a distorted picture of true conditions. The out-of-tolerance part must be separated from in-tolerance parts, but it does not follow that an adjustment need be made in the production equipment. Adjustments are required only when dimensional deviations result from controllable causes. The picture of the general trend obtained by examining a consecutive number of parts is one of the effective ways to recognize the occurrence of controllable causes of defects. Thus, the reject counter registers all rejects but is reset automatically each time an acceptable part is gaged. The machine will be stopped through the reject counter circuit only when the consecutive number of rejects reaches a predetermined value.

In the circuits for salvable/nonsalvable warning, a count registers on the appropriate counter each time a part is within the warning range. The counters are reset automatically when an acceptable part not in the warning range is gaged or when a warning signal in the opposite range is obtained. With this arrangement, the warning counters will cause control actuation only when a predetermined number of consecutive parts are gaged within one or the other warning ranges.

Complex Systems

In general, the relative simplicity of the automatic pedestal-type machine in the example follows from the simple task to be done and the symmetrical, manageable-sized part that is normally handled. But automatic gaging machines can be designed for more complex applications. As an example, consider an application in which the part is heavy and bulky;

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He started with Sheffield in production and planning following several years of association with Steel Products Engineering Div., Kelsey-Hayes Wheel Co., and the Proctor and Gamble Co. Prior to his present assignment he was manager of the Measuray section of industrial X-ray thickness gages, and before that executive project officer on special assignment which included new product development and acquisition and the sale of instruments and controls for machine tools.

Mr. Polk earned his Bachelor of Science degree at Yale University and his Master's Degree in Business Administration at the Graduate School of Business Administration, Harvard University.

He is active in the American Ordnance Association and a committee member of the Research and Advisory Committee of the American Society of Tool Engineers and the Publicity and Meetings Committee of the National Machine Tool Builders' Association. He is a director of Montgomery County Cancer Control, and admissions representative for Yale University, as well as being active in a number of other civic and educational organizations.

points being measured are not readily accessible; eight measurements are checked simultaneously; and the part is classified according to the sensed measurements.

Fig. 7 shows an automatic machine that inspects and classifies four crankshaft bores and four camshaft bores simultaneously in a 6-cylinder automobile engine block. The machine is capable of 100 cycles per hour.

Up to five blocks can be on the in-line transfer type of machine at one time, occupying the following positions: Load, gage, mark, reject, and eject. Blocks are presented to the machine by a customer's transfer mechanism, and enter the load station with the front end of the block first, pan rail up. Moving a block into the load station triggers a limit switch that initiates the transfer through the machine. The blocks are transferred through the machine on flat, serrated rails by a hydraulically actuated, shuttle-type transfer bar with pivoting feed fingers that confine the part. When the gage station is clear, the block is transferred into it from the load station. From above, a shot pin enters a locating hole (also used in the machining operation) at each end of the block.

With block located, the cam and crank bore gaging spindles are pivoted down into the cavities of the block and shifted horizontally approximately 1 inch so that the spindles enter the bores. The inset photograph of *Fig.* 7 shows the gaging spindles for a V-8 engine, but it is representative of the way the gaging spindles are mounted to a carrier plate which is pivoted on an insert bar. The gaging spindles "float" sufficiently to compensate for bore misalignments up to approximately 1/32 inch. Auxiliary air jets at the leading edge of the spindles help to blast loose dirt and chips out of the bore.

The moment the noncontact gaging spindles enter the bores the gaging circuit is initiated. Each pneumatic gaging circuit for the crank bores contains two air-electric transducers, providing for rejection of out-of-tolerance bores and for classification of intolerance bores into one of two size classes of 0.0004 inch each. A single air-electric transducer in each pneumatic gaging circuit for the cam bores provides for either an accept or reject signal. The signals from the control units are fed into a memory system consisting of electromechanical latching type relays.

After the gaging operation has timed out, the gaging spindles are retracted and pivoted upward and out of the block. The locating pins are withdrawn and the block is transferred to the marking station. Here eight spray guns, actuated by signals from the memory, color code the crank bore class on the block with either red or blue paint according to the size group. Blocks that fail to pass inspection are not marked and they are automatically rejected at the reject station.

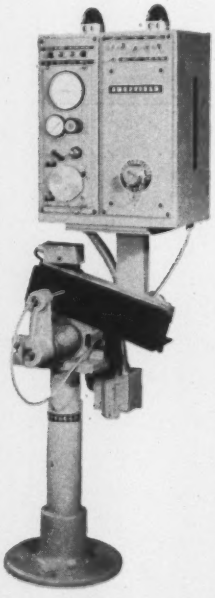
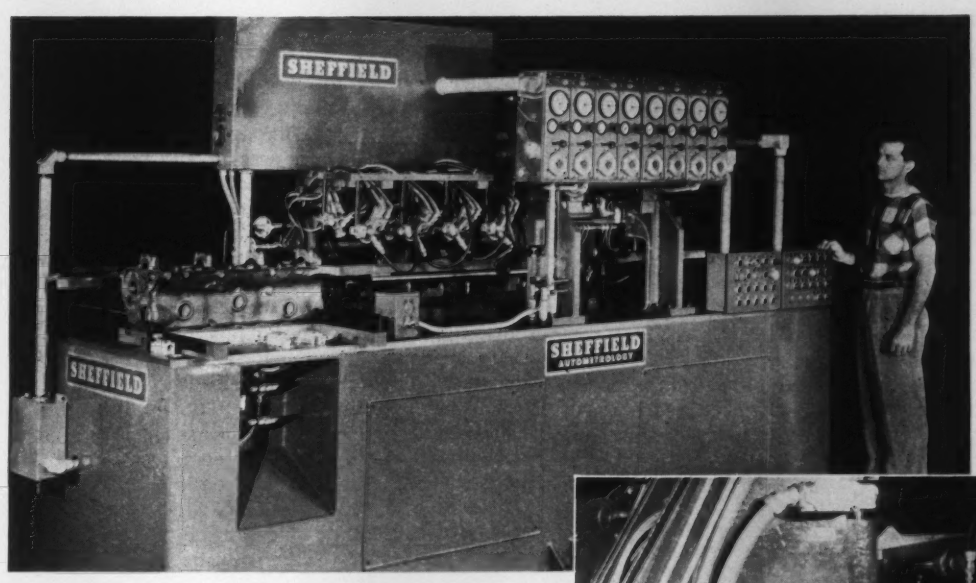


Fig. 6 — Pedestal mounted equipment is designed to fit directly into production line. Parts to be gaged are presented to inclined chute where a horizontally moving gage head is automatically inserted into bore of part. Note the incorporation of a previously described modular unit in the control panel mounted above the gaging spindle.



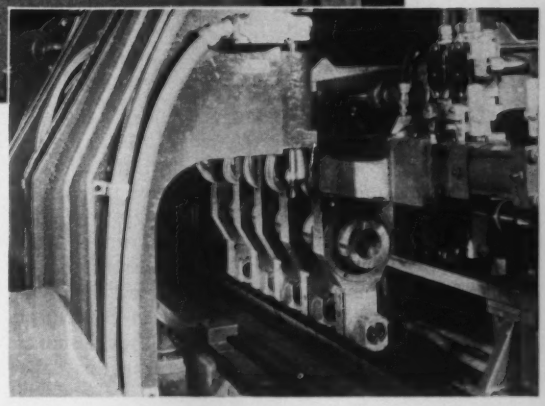


Fig. 7—Capable of 100 cycles per hour, automatic equipment inspects and classifies four crankshaft and four camshaft bores simultaneously. Engine blocks move from right to left in the machine as shown. Devices shown to the left and below the massed modular units are automatically actuated paint spray heads which color code individual bores into one of four classes depending on the sensed measurements. Insert photo shows typical way in which inspection heads are mounted in machine. As a unit the heads are capable of being pivoted down into the block cavities and then shifted horizontally to insert individual gage heads into bores.

Practical Considerations

Manufacturing, inspection, and management considerations enter into the development and acceptance of automatic gaging systems. Manufacturing and inspection variables that must be considered include: Part size, part configuration, material, finish, production part changes, tolerance, part handling, type of gage elements, and inspection rate.

For automatic gaging applications, each part must be analyzed individually, and a system devised within the parameters of economic and technical boundaries. Generally, what can be gaged manually can be gaged automatically, keeping in mind that physical dimensions and characteristics of the part to be presented to the gage must be defined; and the manufacturing process must be capable of producing parts within this definition.

Many types of methods and devices are available to transfer simple or intricate and irregular shapes, small or large, into and through the gage. Typical part transfer methods include gravity feed, endless belt, indexing chain shuttle bar with pivoting feed fingers, crossfeed and push movements. It is possible, in many instances, for a gage maker to design the gage for adjustable or interchangeable tooling to accommodate changes in part size and shape.

Of greater interest is the method or procedure to follow where a part has a number of check points within an area too small to accommodate all gaging elements. In this case, two solutions are suggested: If gage time permits, a second set of gaging elements is indexed into the part, or the part is transferred to another gaging station to complete the inspection. In any event, close tolerance dimensions should be gaged first, broader tolerances next. With this approach, there is less chance of wasting gaging time on a part destined to be rejected because the finer tolerances are unacceptable.

Part alignment in the gaging station is an important factor in automatic gaging. Wherever possible locating surfaces for the inspection operation should be the same as those used in machining, or the locating surfaces may be determined by the functional or end use of the part. Gaging elements should "float" to permit slightly misaligned bores or dimensions to be gaged without damaging the tooling or affecting the gage reading. On small thin wall parts, the type of chuck or clamping device used to position the part during gaging must not distort it.

Material and finish of the workpiece dictate the type of gaging elements to use. Nonporous metal and nonmetal parts with surface finishes below 35

rms are generally gaged with pneumatic sensing units such as open-type air jets, noncontact air jet spindles, air snaps, air rings, or, if contact type gaging is desired, with pneumatic gage cartridges.

The gaging of thin-walled parts, narrow lands, and rough or porous surfaces frequently calls for a specific type of gage element. For example, rough or porous surfaces and finishes are gaged with contact-type spindles.

Broad tolerances on the order of 0.005 inch to 0.080 inch can be gaged directly with contact-type pneumatic gage cartridges. Tolerances above that can also be gaged with these catridges by means of deamplifying linkages.

Part Preparation

As in any precise measuring practice, it is desirable to have clean parts presented to the automatic gage. Where parts are washed in hot or warm liquids, they should be allowed to cool to uniform temperature before being gaged. In gaging holes, auxiliary air jets can be incorporated into the leading edge of the gaging spindle to assist in the removal of loose chips and dirt. Normally, the responsibility for selecting the method to clean parts lies with the user of the gage, not the gage maker.

Controlled environmental temperature is desirable where tolerances on the order of 0.0002 inch or better are encountered. Here, again, part size, wall thickness, dimensions, and tolerances serve to establish the degree of environmental control necessary to achieve the accuracy objective.

How many parts per hour can be gaged with an automatic gage utilizing a pneumatic gaging circuit? Here, too, size, tolerance, material, and method of handling are controlling factors. Quite frequently, the rate of inspection is limited not by the speed of air gaging but by material handling. Under certain conditions, it is possible to gage at rates up to 4000 parts per hour. More normal are automatic gaging rates from 1000 to 1500 parts per hour.

Management Considerations

Unlike manual inspection methods which may allow faulty parts to be accepted because of human errors in the inspection setup, gage reading, or judgement, an automatic gage accepts only parts that are within the prescribed tolerance limits set into the gage. There is no compromise; automatic gaging makes no arbitrary decisions.

Thus, the basic reason for automatic gaging is the protection of quality. However, unless the inspection problem is one where the need for accuracy transcends monetary considerations, it will be necessary to show how automatic gaging can cut inspection costs. Experience indicates the cost analysis should be brief and simple. The analysis should include the number of units inspected and a comparison of present unit inspection costs with the proposed unit cost with automatic gaging.

In addition to direct savings which may be possible with automatic gaging, the analysis should cover those savings accruing through the reduction in floor space requirements, the smaller numbers of individual gages that will be bought and stocked, and the elimination or reduction of gage records and attendant paperwork.

The very essence of automatic gaging is integrated control of the manufacturing process in order to produce uniform high quality production. As a result, its influence cuts across department lines and extends into areas and policies beyond those normally ascribed to quality control or inspection departments.

Experience has shown that the most successful automatic gaging systems are those that were developed, within the framework of an over-all concept of controlling quality, by an established reputable manufacturer.

Similarly, maximum control over quality and cost in manufacture of the gaging equipment is accomplished with the "systems approach" in which the gage maker is entrusted with, and is responsible for, the designing, building, calibration, installation, servicing and repairing of the gaging equipment. To split the responsiblity for designing and building an automatic gaging system between the user and an outside source creates difficulties in evaluating responsibility for final performance.

can we help?

It has been pointedly mentioned at various times that in engineering automated systems new as well as old techniques and devices may prove extremely useful. Practical results require the investigation of all available equipment that can contribute to the effective development of suitable automatic lines. Information on such equipment is presented in various departments of the magazine each month as useful data become available. To aid in obtaining detailed data for further evaluation a post card is included on page 19. Take advantage of this service. The Editors will be glad to help in this or any other way.

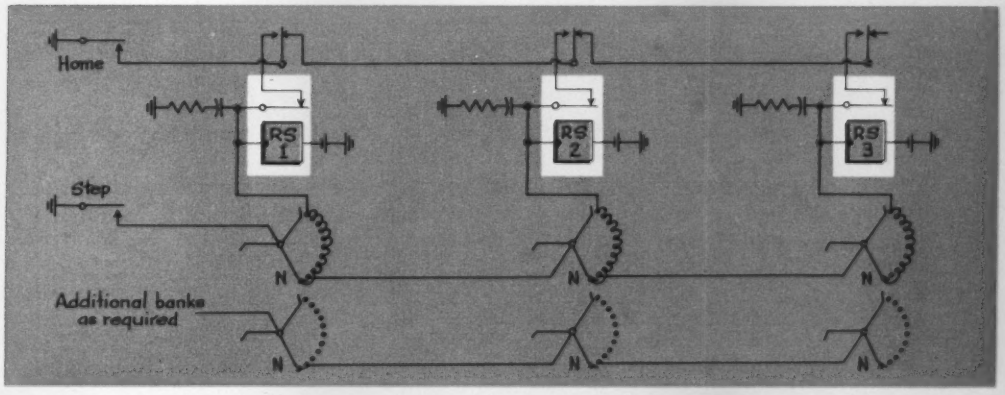
ROTARY STEPPING SWITCHES

By L. B. MITCHELL
Staff Engineer, Industrial Products Div., Automatic Electric Sales Corp., New York, N. Y.

IN BOTH control and data handling systems, requirements are often encountered in which circuits must provide for sequential actions or switching between circuits or components to obtain successive steps. The frequency of this type of problem is attested to by the existence of a special switch form in which a wiper assembly is successively stepped from contact to contact under electromagnetic control.

Rotary stepping switches can be provided in which literally hundreds of contact points are available, allowing the switches to play an important role in modern systems where ordered and interlocked signals are required.

The following circuits, accompanying this last article in a series of data sheets on the industrial application of telephone-type equipment, are concerned with some of the uses of rotary stepping switches. In following the circuit actions which are indicated, it should be remembered that the switch actions are of the indirect drive type, i.e., the wipers are advanced during release of the armature rather than during magnetization of the coils. Typically, the rotary stepping switch is provided with an off-normal spring assembly to indicate that the wipers are in a position other than the normal or home position. The use of such off-normal contacts in a circuit is also illustrated.



Tandem Stepping

When it becomes necessary for a series of rotary stepping switch positions to be connected in sequence with a total exceeding the capacity of one rotary stepping switch, a circuit such as that shown can be used.

As illustrated, each time the step contacts close, a circuit is closed through the bank of *RS* 1 (Rotary Stepping Switch 1) to the coil of *RS* 1. The rotary switch will take one step for each generated step impulse until it reaches bank position where its wipers extend the step impulses to the wiper of the next succeeding rotary stepping switch. Successive impulses will position the succeeding rotary stepping switch in the same manner. Additional banks as required on each of the rotary stepping switches in the series can be wired as shown for multiple lead switching.

The reset of the switches in a tandem chain is achieved by closure of the Home contacts. The off-normal springs on *RS* 1 will cause the rotary stepping switch to step in a self-interrupted manner until the Home position is reached. With *RS* 1 in the Home position, the off-normal springs transfer to the position shown and extend the homing circuit to *RS* 2, and, similarly, on to the last rotary stepping switch in the chain.

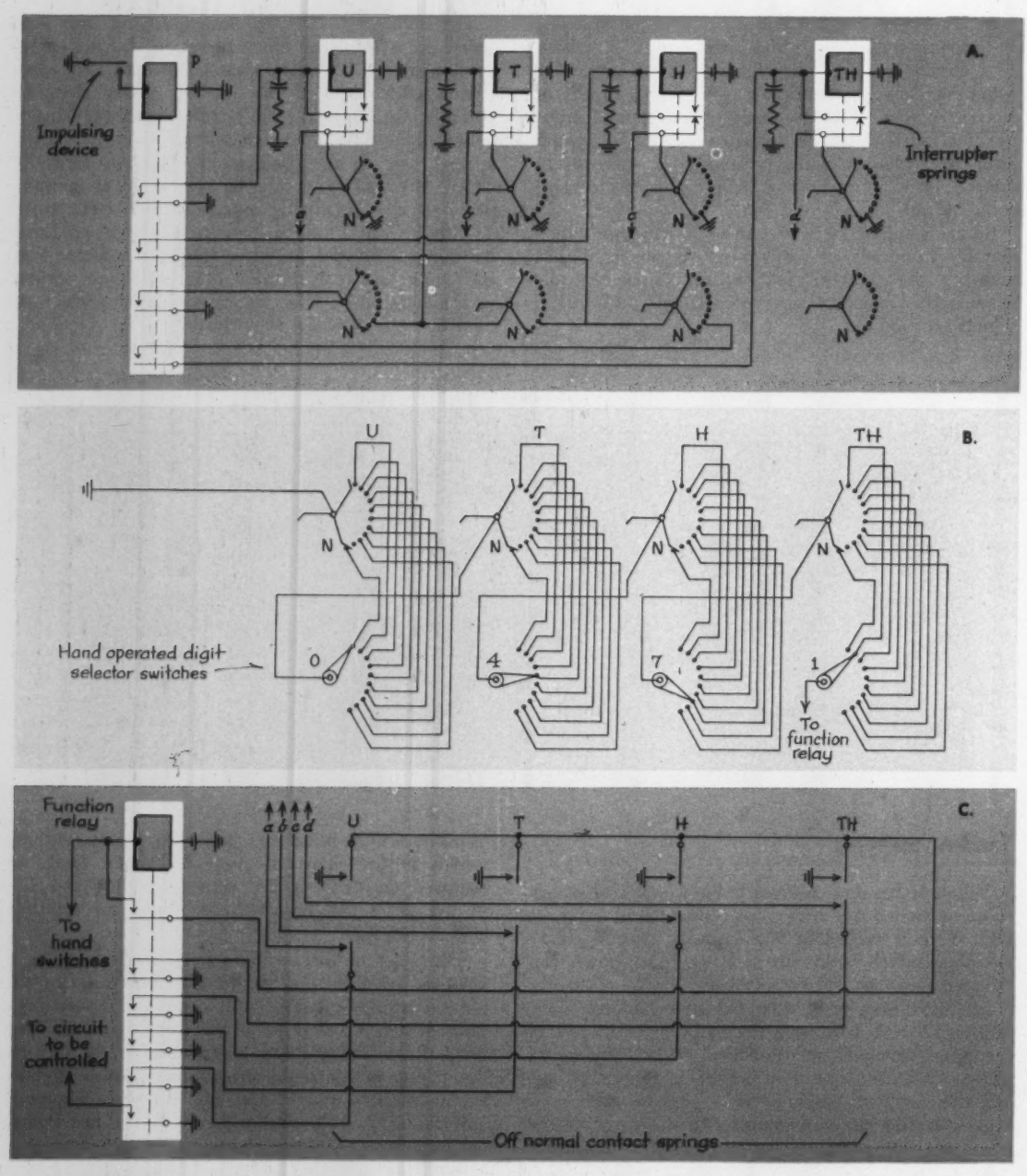
Decimal Count And Carry

The circuit in *Fig. A* depicts means for operating eleven point rotary stepping switches in a ten point manner. It further provides the interconnections necessary to "carry" one impulse forward to the succeeding decade or decades when the decade or decades preceding the one in question are in position 9 and another impulse is received.

Relay *P* should be specifically engineered as an impulse receiving and repeating relay. The contacts on Relay *P*, which are used for the "carry" impulse to succeeding decades, should be adequate for interrupting the current imposed by the various rotary switches involved.

Relay *P* will follow each generated impulse from the remote impulsing device. With the circuit in the condition drawn, the first operation of Relay *P* closes a circuit to the Units stepping switch, which will operate. When Relay *P* restores, the Units stepping switch circuit is opened and the Units stepping switch restores and advances its wipers one step.

When nine impulses have been received by Relay *P* and repeated to the Units stepping switch, the



wiper of the Units stepping switch associated with the "carry" function is in a position (on the ninth contact) such that the next operation of Relay *P*, in addition to operating the Units stepping switch coil, will also close the circuit through the bank and wiper of the Units stepping switch to the coil of the Tens stepping switch. Thus, during this impulse both the Units and Tens stepping switches are energized and, following the impulse, they will both advance one step forward. At this time the Units stepping switch encounters a ground on the "skip" bank which is extended through the interrupter springs to the Units stepping switch coil. The Units stepping switch will take one self-interrupted step to the eleventh (or normal) bank contact.

At this point the circuit has received a total of ten impulses, the Tens stepping switch is on its first bank contact, and the Units stepping switch is on its Home bank contact.

When 99 impulses have been received, both the Units and the Tens stepping switches will be positioned on their ninth bank contact. The next operation of Relay *P*, in addition to energizing the Units stepping switch, will also energize the Tens stepping switch and, through the carry bank of the Tens stepping switch, will energize the Hundreds stepping switch. When this impulse is complete and Relay *P* restores, the Units, Tens, and Hundreds stepping switches will advance one step. At this time both the Units and Tens stepping switches are on their tenth bank contacts, and their respective skip banks provide a circuit through their respective interrupter springs to their individual coils. Both rotary stepping switches will take one self-interrupted step to the eleventh or Home bank contacts. The carry and skip function into the Thousands register is made in exactly the same manner.

Predetermined Counting Chain

The circuit shown in *Fig. B* is associated with both *Fig. A* and *Fig. C*. The equipment represents one level of each of the rotary stepping switch decades and four hand operated digit selector switches. As drawn, the predetermined number to which this counter is set is 1740. When the position of the four decade rotary stepping switches is such that 1740 impulses have been received, a chain circuit is completed from the positive potential on the Units stepping switch to the output lead to *Fig. C*. The completion of this chain circuit indicates that the predetermined count has been achieved.

As *Fig. A* and *C* have been drawn, if the digit selector switches are all set in the zero position and the rotary stepping switches are all "home", application of power to the circuit will cause the function relay in *Fig. C* to operate. If it is considered inadvisable for this to take place, the positive potential shown connected to the wiper of the Units stepping switch can be removed, and the wiper of the Units stepping switch can be connected to the common lead in *Fig. C*. The common lead appears on all rotary switch off-normal spring assemblies and is used to lock the function relay in *Fig. C* until all rotary switches have been restored to Home.

Count Complete Function, Output And Reset

Fig. C depicts the circuits necessary to receive the signal generated as a function of an achieved predetermined count in *Fig. B*, in conjunction with *Fig. A*, and from this signal cause reset of the predetermined counter to 0000. At the same time a signal can be transmitted from this circuit to some remote point indicating that the counting device has in fact achieved the predetermined number and is being reset to zero.

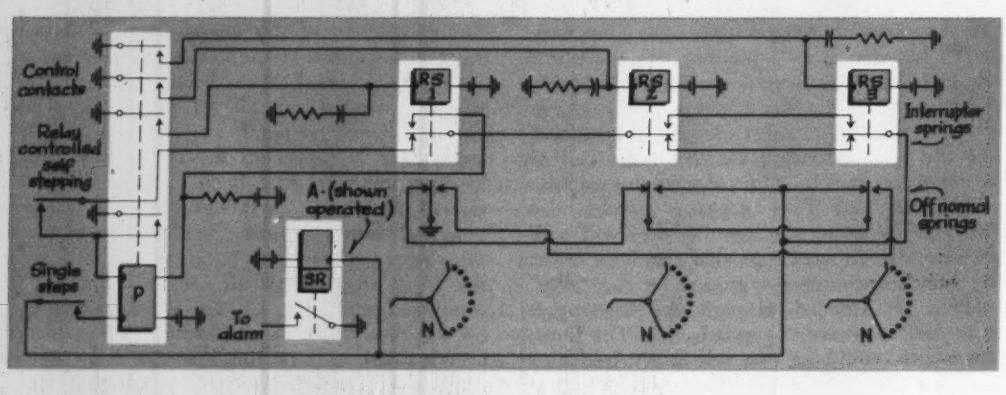
The circuit shown illustrates off-normal spring assemblies associated with each of the decades involved in the counter device. The function relay will operate when the chain circuit in *Fig. B* is complete. When the function relay operates, it will lock itself to any and all rotary stepping switches which are off-normal. When function relay is operated, it repeats a signal to the controlled remote device, indicating a completed predetermined count, and closes circuits through the individual off-normal spring contacts (leads *a*, *b*, *c*, and *d* in *Fig. A*). These four circuits cause self-interrupted homing of the individual rotary stepping switches. When each of these switches reaches the Home position, its off-normal springs achieve the condition shown in the sketch and self-interrupted stepping ceases.

When all rotary stepping switches in the counter are in the Home position the locking circuit for the function relay is removed. The function relay releases, opening the output signal and all homing circuits. Successive impulses to Relay *P* in *Fig. A* can now be acknowledged for a repeated counting cycle.

"Lock Step" Synchronization

It sometimes becomes necessary to operate two or more rotary stepping switches simultaneously in order that a sufficient number of electrical circuits can be switched for the particular logic involved.

Rotary stepping switches, like any other manufactured product, are subject to slight variations in their individual performance. Operate and release times for such devices can be quite closely predicted, but, at the same time, these predicted values will be median values, and it is possible to have acceptable units which display some dissimilarity in their operating characteristics. This circuit illustrates one method of assuring simultaneous stepping by a group of three rotary stepping switches. The lock pulsing feature of this circuit requires only the equipment shown for Relay *P* and *RS* 1, *RS* 2, and *RS* 3. The circuit involving Relay *A* and the off-normal springs



is a refinement which will cause the circuit to stop within ten steps should any one switch get out of synchronization.

Closure of the Single Steps contact at some remote point will operate Relay *P*. Relay *P* operates and locks itself in the operated condition on its second winding. With Relay *P* in the operated condition, individual circuits are closed to the three rotary stepping switch coils. When all three rotary stepping switches have completely operated their individual armatures, a chain circuit is closed through the normally-open interrupter spring contacts to the junction between the second winding of Relay *P* and the series resistor.

The closure of this circuit shorts out the Relay *P* winding, causing Relay *P* to restore (presuming the Single Steps contact has opened prior to this). When Relay *P* restores, the individual circuits to the rotary stepping switches are open, and the rotary stepping switches will restore their armatures and advance their wipers one step.

The circuit as described will continue for each closure of the Single Steps contacts. Should the generated impulse at the Single Steps contacts be extremely long, the complete operation of the three rotary switches will short out the second winding of Relay *P* as described, but Relay *P* will remain operated until the Single Steps impulse is opened. This presents no difficulty in operation of the circuit. The locking of Relay *P* and the acknowledgement from the rotary switches that they are in fact completely operated insure that any impulse long enough to operate Relay *P* will cause reliable operation of all of the rotary switches involved.

Similarly, it is sometimes necessary to step rotary stepping switches in a self-stepping manner in synchronization with other rotary stepping switches. To achieve this, the relay controlled Self-Stepping contacts are closed. Assuming all rotary stepping switches in the circuit are in the de-energized condition, a circuit is closed through the normally closed interrupter spring contacts to the second winding of Relay *P*. Relay *P* will operate and lock. Relay *P*, when operated, closes individual circuits to the three rotary stepping switches energizing their respective coils. When the rotary switch armatures are completely operated, the rotary switch interrupter springs will now close a circuit through their normally open contacts to the junction between the second winding of Relay *P* and its associated resistor, causing Relay *P* to be shorted. Relay *P* releases and opens the three rotary stepping switch coils. The three rotary stepping switches will restore, advancing their wipers, and, when all three rotary switches are in the de-energized state, the interrupter spring normally-closed contact chain is re-established, causing reoperation of Relay *P* for the next impulse cycle.

The synchronization of the rotary stepping switches can be verified. As long as the off-normal springs on the three rotary stepping switches transfer simultaneously as the individual switches pass through the normal position, the circuit to Relay *A*, the Single Steps contact, and the armature interrupter spring of *RS* 3 will remain established. If, however, any one rotary switch either leads or lags any of the others, the first one to pass through the normal position will cause the circuit to be interrupted, resulting in the instantaneous stopping of the entire circuit. At this time Relay *A* will restore and an alarm signal can be created.

An alternate method for verification would require that the positive potential be provided to the Single Steps contacts and the armature interrupter spring of *RS* 3 directly, and the off-normal springs be deleted. Relay *A* would be connected to a wiper of *RS* 1. All bank contacts on this level of *RS* 1 would be connected to similar bank contacts on a level of *RS* 2. The wiper of another level on *RS* 2 would be connected to the wiper of the first level on *RS* 2, and all contacts on this second bank level would be connected to similar contacts of a level on *RS* 3. The wiper of *RS* 3 would be connected to positive potential. Relay *A* would be a quick-acting relay with a release time less than the operate time of any of the rotary stepping switches. With this type circuit an alarm condition will be established the instant any one switch gets out of phase with any other switch in the system.

This alternate verification circuit as described will require two bank levels on one rotary switch and one bank level on all the rest of the rotary switches when an odd number of switches is involved. If, however, an even number of rotary switches is involved, the verification circuit will require only one bank level on each rotary stepping switch.

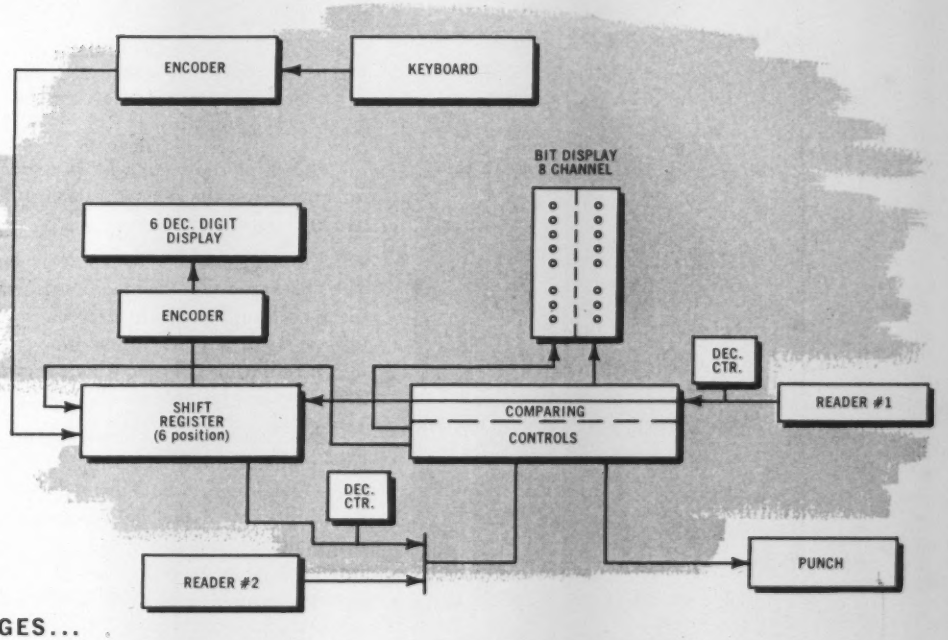
One sound solution
to the problem of quickly providing error free paper tapes to program equipment ranging from machine tools to satellite communications gear is Tally/Seattle's Model 150 Tape Console.

Here is a device which fully automates tape production. It is the only unit available specifically intended for the high speed preparation, verification, and duplication of error free perforated tape.

Tally tape consoles are available in either vertical or horizontal cabinets.

SIMPLIFY AND AUTOMATE

PUNCHED PAPER TAPE PRODUCTION WITH THE NEW TALLY TAPE CONSOLE



Schematic Arrangement of Components in Tally Tape Console

Basically, the unit consists of an alpha numeric keyboard, control and comparison section with six-digit decimal display, two tape readers and one tape perforator.

ADVANTAGES...

1. *Overall system flexibility and versatility with full operator control.*
2. *Keyboard entry to shift register and visual display which lets the operator edit keyed information prior to actual tape punching.*
3. *Produces accurate and complete copy without overpunching, cutting, or splicing of tapes.*
4. *Tape to tape duplication and/or verification at up to sixty characters per second.*

Want more information? Your nearby Tally engineering representative will be glad to provide you with complete technical information or you may write directly to Department 01-3.

SPECIFICATIONS—OPERATING SPEED: Variable from 0-60 characters per second. STANDARD CODE CHANNELS: 5, 6, 7, or 8. STANDARD TAPE WIDTHS: 0.687, 0.875 and 1.000 inch (interchangeable). SUPPLY AND TAKE-UP: 6" reel for 400' maximum; 10" reel for 1000' maximum; Fan Fold for 400' maximum. CODE HOLE SIZE: 0.072" diameter on standard 0.1" centers. FEED HOLE SIZE: 0.047" diameter. ALIGNMENT: Code holes and feed holes have a common center line. POWER REQUIREMENTS: 117 vac ±10%, 60 cps, 500 watts. DIMENSIONS: 51¼" H x 20⅝" W x 23⅝". PRICE, f.o.b. Seattle: $8,000.

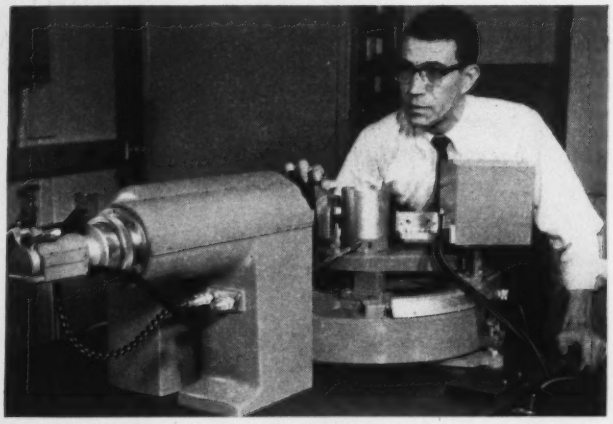
TALLY
REGISTER CORPORATION
1310 Mercer Street
Seattle, Washington
Phone: MAin 4-0760

5

Circle 685 on Page 19

HE X-RAYS WOOD...

to help make telephone poles last longer



Chemist Jack Wright developed the use of this X-ray fluorescence machine for testing the concentration of preservatives in wood. Here he bombards a boring from a test telephone pole with X-rays.

This Bell Labs chemist is using a fast, new technique for measuring the concentration of fungus-killing preservative in telephone poles.

A boring from a test pole is bombarded with X-rays. The preservative—pentachlorophenol—converts some of the incoming X-rays to new ones of different and characteristic wave length. These new rays are isolated and sent into a radiation counter which registers their intensity. The intensity in turn reveals the concentration of preservative.

Bell Laboratories chemists must test thousands of wood specimens annually in their research to make telephone poles last longer. Seeking a faster test, they explored the possibility of X-ray fluorescence—a technique developed originally for metallurgy. For the first time, this technique was applied to wood. Result: A wood specimen check in just two minutes—at least 15 times faster than before possible with the conventional microchemical analysis.

Bell Labs scientists must remain alert to *all* ways of improving telephone service. They must create radically new technology or improve what already exists. Here, they devised a way to speed research in one of telephony's oldest and most important arts—that of wood preservation.

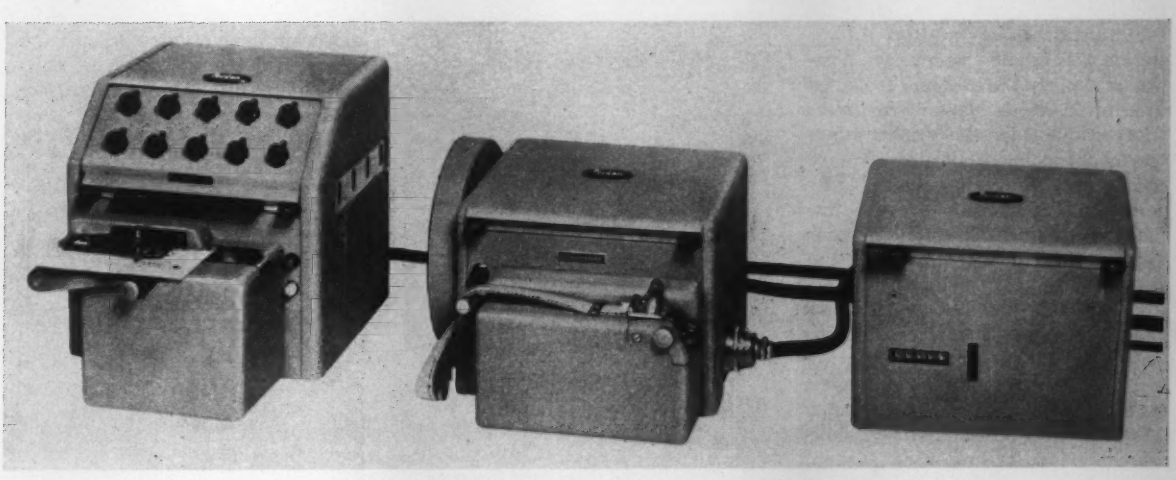
Nature still grows the best telephone poles. There are over 21 million wooden poles in the Bell System. They require no painting, scraping or cleaning; can be nailed, drilled, cut, sawed and climbed like no other material. Scientific wood preservation cuts telephone costs, conserves valuable timber acres.

BELL TELEPHONE LABORATORIES

World Center of Communications Research and Development

AUTOMATION new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card on page 19.



Collectadata transmitter (left) converts input data from punched tape or card into signals and sends them to receiver (center). Receiver is an 8-channel tape punching unit which can receive signals from one or more transmitters through a common cable. The time code emitter (right) is also connected by cable to the receiver and provides a 5-digit time indication which is punched into the receiver tape when called for by a certain signal from a transmitter.

Data Collecting System

PROBLEMS such as how to achieve accurate and up-to-the-minute control of work areas from management positions can be handled with the use of a data collecting system, designated Collectadata. The system, designed by **Friden Inc.**, San Leandro, Calif., consists of readers and punches which collect data from several points of origin to a central processing point. The points of origin can be plant work areas, accounting sections, or transaction stations. Multiple readers or transmitters are connected to a single punch or receiver on a cable-sharing basis. Input data at the point of origin can be in the form of 8-channel tape, edge-punched cards, or tab cards punched with the Hollerith code. Data are received in the form of 8-channel punched tape.

In operation, an input document (tape or card form) is coded by combinations of punched holes to designate order number, part number, and quantity. This form accompanies a production order through each step of the manufacturing process. As the work is started or completed, a card or tape with coded information covering the job is inserted in a transmitter, where it is automatically read. Variable data are inserted by manually setting dials. All variable and constant input is then channeled by cable to a data collecting center where it is reproduced in a continuous punched tape on a receiver. Facilities can be provided at the receiver for connecting a time code emitter which will automatically read out a time indication with each transmission.

Some of the features of the system include: A line lock-out which prevents transmission from more than one transmitter at a time; a parity check which detects if an erroneous code is transmitted and records an error; and a positive card insertion which checks if the card is inserted properly. If the card is inserted backward, upside down, or in the wrong order, no transmission will take place.

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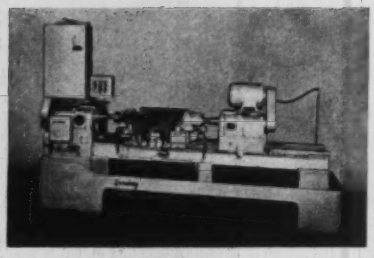
Walking Beam Loader

Device is designed for company's drilling and centering machine, will automatically load, center, and unload eight-cylinder camshafts, using a walking beam principle. The camshafts are transported from the previous operation by a conveyor and roll down to a fixed stop on the loading rails. In operation, the loader loads a rough piece and



removes a finished one simultaneously. At the end of the machine cycle, the center drills retract and the vises open, allowing the finished piece to drop into a stationary cradle which is positioned slightly lower than the center line of the vise jaws. An electrical contact in the cradle starts the loader motor, imparting a rotary motion to the carrier arms. The unloading arms pick up the finished piece and deposit it on conveyor rails. At the same time, the loader arms pick up a rough part and lower it into the vise jaws which automatically clamp it into position. The machine starting clutch is then automatically engaged, the part is centered, and a new cycle begins. **Seneca Falls Machine Co.**, 21 Fyfe Bldg., Seneca Falls, N. Y.

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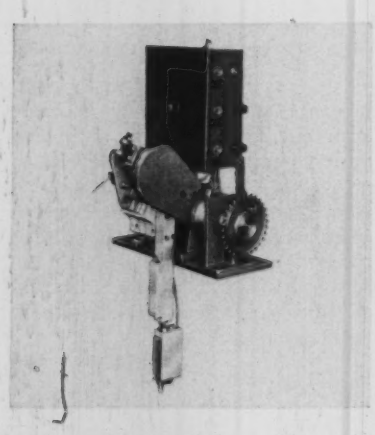

Tape Applicator

Tape applicator can be incorporated into existing bag end closure equipment to produce moisture and siftproof closures. It is suitable for bags which contain hygroscopic materials such as chemicals and fertilizers. Model DN is a nozzle type applicator that has a tape folding assembly with two adjustable tape guides. The applicator works in conjunction with the folder to dispense exactly the right amount of hot melt at an exact rate synchronized with the folding and creasing operation. The folding assembly can accommodate a number of different weights of tapes and it can be mounted in a variety of positions. **United Shoe Machinery Corp.**, 140 Federal St., Boston 7, Mass.

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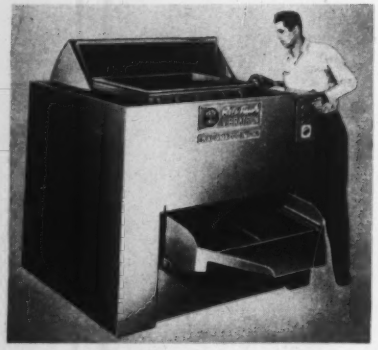

Vibrating Finisher

Hopper-fed vibrating unit can finish cast, forged, stamped, and machined parts with hard-to-reach shielded and internal surfaces. A removable, double-decked vibrating separator in the base of the machine separates parts and media as well as fragments from the media. Unit designated Vibratron, features an automatic discharge of finished parts onto a conveyor. **Roto-Finish Co.**, Kalamazoo, Mich.

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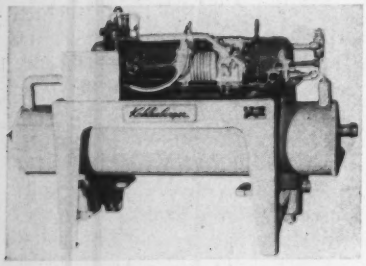
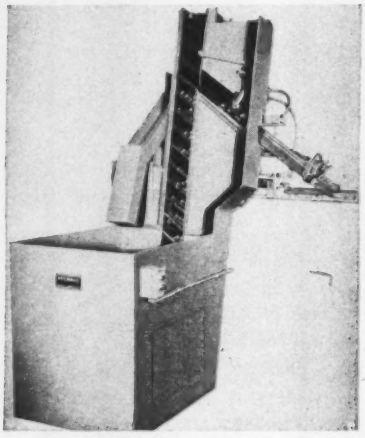


Air Dryer

Designed on the principle of subdewpoint refrigeration, instrument air dryer can be used for instrumentation, controls, or processes, condensing water and oil vapors from compressed air. Features of the dryer include: Automatic return oil trap on the compressor discharge and a semihermetic type motor compressor that is vibration spring mounted and coupled with flex couplings to the suction and water regulating valve to provide consistent condensing pressure. Heat exchangers are refrigerant cooled and ASME coded at 150 psi. Helical coils are baffled to give proper air flow and condensate removal. This removal is accomplished through blow-down valves at the drain points in heat exchangers. **Kohlenberger Engineering Corp.**, 1600 W. Commonwealth Ave., Fullerton, Calif.

Circle 405 on Page 19



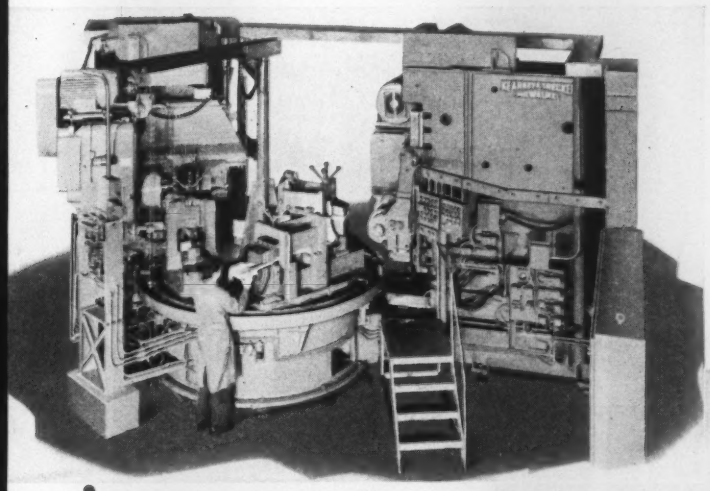
Parts Feeder

Automatic parts feeder is designed to deliver parts to centerless grinders, inspection equipment, assembly machines, and broaches at a rate up to 2400 pieces per hour. Automatic bank controls regulate the flow rate and prevent damage caused by parts cascading back into the loading hopper. An escapement mechanism releases one part at a time in correct feeding orientation. Features of Model 2200-C are: 6 cu ft hopper and a self-contained power drive with variable speed. Feeder is adaptable to a wide range of external orienting devices which can be applied without special tooling. **Feedall Inc.**, 38399 Pelton Rd., Willoughby, Ohio.

Circle 406 on Page 19

MMT-PE

Kearney & Trecker builds production machine tools for every industry*

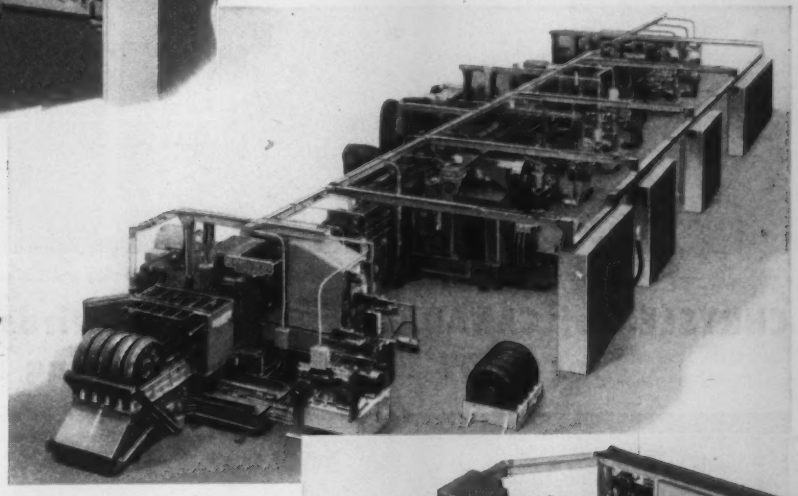


For Over 60 Years, Kearney & Trecker engineers have helped solve production problems of metal-working industries. Whatever your product or problem, Kearney & Trecker Custom Engineering Service can help you find cost-reducing solutions. Backing up this outstanding service is one of the most up-to-date plants in the world devoted exclusively to manufacturing modern production machine tools.

For the Whole Story

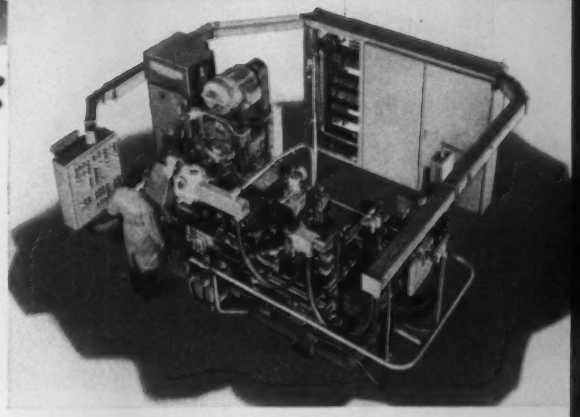
. . . ask your local Kearney & Trecker representative for Bulletin SMD-57 . . . 16 pages packed with *"Performance-Proved"* examples of how K & T Custom Engineering has paid off for manufacturers in every industry.

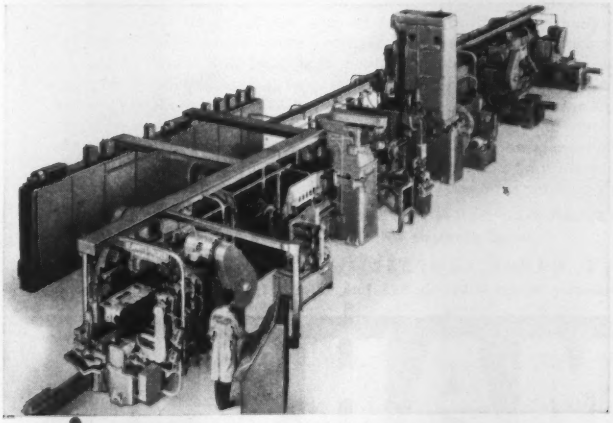
*** STEAM TURBINE INDUSTRY**
3 station rotary index machine mills root ends on large turbine buckets.



RAILWAY EQUIPMENT INDUSTRY *
30 station railroad car wheel boring, facing, and turning machine.

AIR CONDITIONING INDUSTRY *
Mills cylinder pads and feet on a variety of compressor housings.





*** DIESEL ENGINE INDUSTRY**
15 stations — 31 milling, drilling, reaming operations on 6, 8, 12-cylinder, V-type engine blocks.

KEARNEY & TRECKER MILWAUKEE ®

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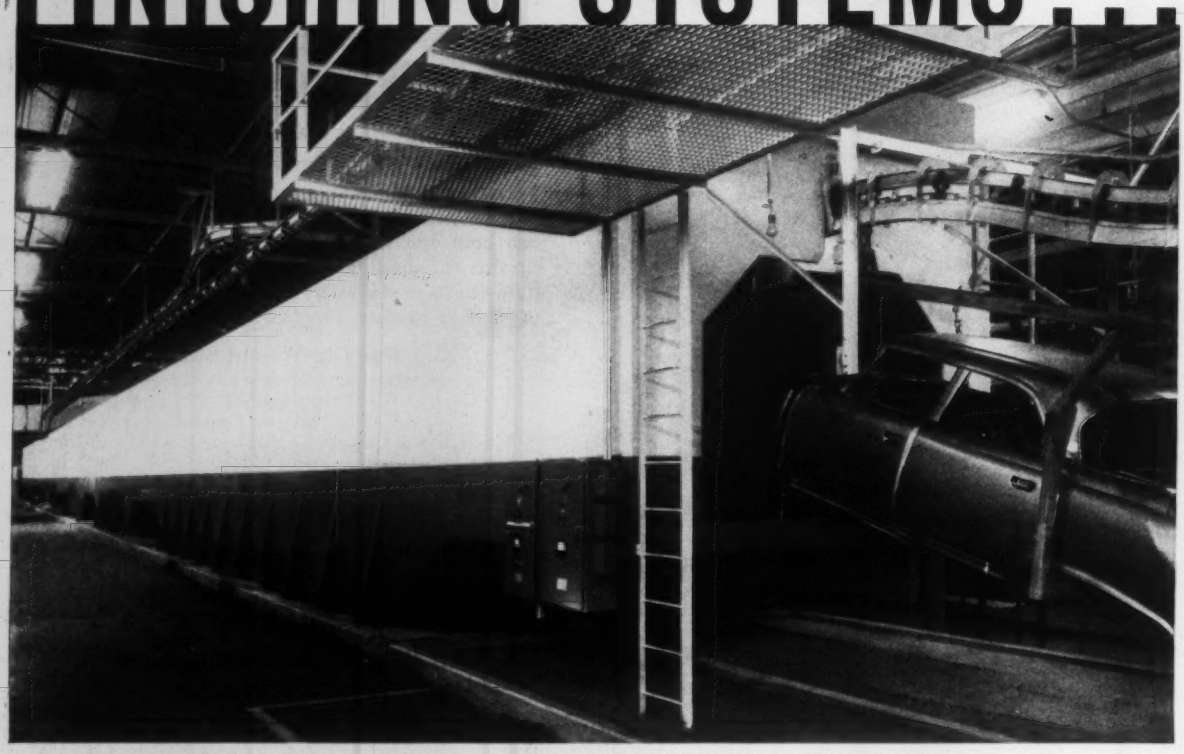
FINISHING SYSTEMS...



Mahon Six-Stage Combined Dip and Spray Cleaning, Rust Proofing and Surface Preparation Machine.

CHRYSLER of CANADA Installs New Antirust Facilities for BODY FINISHING—Including DIP PRIME COATING!

Primer Dip Tank—9000 Gallons of Water-Reducible, Rust-Inhibiting Primer. Bodies are Immersed to a Depth of 18" and are Soaked in this Rust-Proofing Primer for One Minute and Thirty Seconds.

In the new, conveyorized anticorrosion equipment recently installed by Mahon in the Windsor Plant of Chrysler Corporation of Canada, Limited, the bodies pass through seven operations of Cleaning, Rust Proofing and Dip Prime Coating.

In the first six operations of cleaning and surface preparation, which include a phosphate coating and chromic acid bath, the bodies are subjected to high intensity impinging sprays while immersed to a depth of 18" in the same chemical solutions maintained at prescribed level in long tanks. In the seventh operation the bodies are dipped to a depth of 18" into a 9000 gallon tank of water-reducible, rust-inhibiting primer—bodies soak in this armour-like rustproof primer for one minute and a half to ensure effective coating of all the metal surfaces which would otherwise be inaccessible in the complex configurations of unitized body construction.

When you consider buying a new finishing system, or any unit of finishing or processing equipment, you, too, will want to discuss methods, equipment requirements and possible production layouts with Mahon engineers . . . you'll find them better qualified to advise you, and better qualified to do the initial planning and engineering which plays such an important role in the ultimate operating efficiency of specially designed equipment of this type.

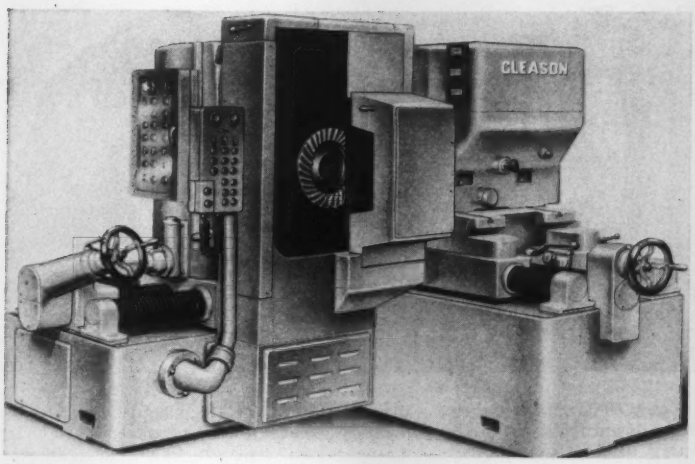
See Sweet's Plant Engineering File for Information and Representative Installations, or Write for Catalogue A-660

THE R. C. MAHON COMPANY • Detroit 34, Michigan

Sales-Engineering Offices in Detroit, New York, Chicago, Los Angeles and San Francisco

... the EXPERIENCE that goes into the PLANNING and ENGINEERING of MAHON EQUIPMENT is the item of GREATEST VALUE to YOU!

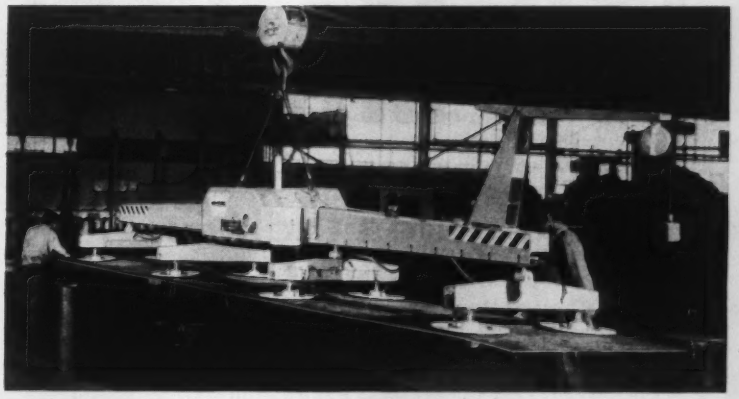
MAHON



Gear Lapper

Spiral bevel and hypoid gears up to 36 inches in diameter can be lapped, with variable spindle speeds ranging from 200 to 2000 rpm. The machine can handle any shaft angle from 10 to 130 degrees. In operation, while the lapping compound is pumped on the gear pair, the relative position of gear and pinion is changed continually and automatically to lap the entire surfaces of the teeth. A swinging motion of the pinion head sweeps the bearing along the length of the tooth. A lateral motion of the gear head moves the bearing up and down the tooth profile, while a lateral pinion head motion maintains uniform backlash. The lapping time for any position of the tooth is regulated by a dial setting. Feature of the machine is an automatic backlash mechanism which maintains the same lash from pair to pair, regardless of dimensional differences in the gears. **Gleason Works,** 1000 University Ave., Rochester, N. Y.

Circle 407 on Page 19



Overhead Vacuum Lift

Vacuum lifting system consists of a motor and pump unit and a vacuum gripper. It can be used in overhead crane systems for lifting polished surfaces such as stainless steel and glass, as well as rough textures like concrete and diamond tread plate. Any number of grippers can be used to obtain the required lifting capacity for an application. Grippers are available in a range of sizes up to 25 inches in diameter, with lifting capacities up to 2000 lb per gripper. In the event of power failure, the system has a safety reserve tank which maintains sufficient vacuum to continue to hold a load for hours after power has stopped. **Whiting Corp.,** 157th & Lathrop Ave., Harvey, Ill.

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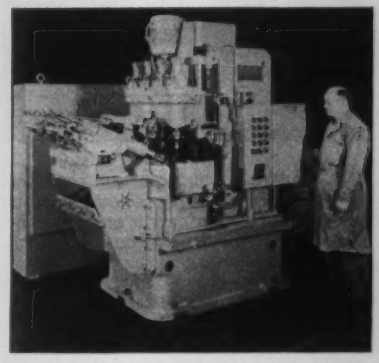


Sphere Turning & Honing

Generating precision truncated spherical surfaces is accomplished by two machines—Model 5-VMB, a single-spindle machine that performs the cutting operation and Model 758 (shown), a 4-spindle machine that performs the honing operation. Truncated spheres that are mounted on shafts, such as ball valves, rod ends, and self-aligning bearings, can be machined by placing them on an arbor. Solid spheres with integral shanks, such as ball studs are located on the taper and clamped in the thread. The work is positioned on an inclined axis so the center of the ball at the crown and at the point at which the shoulder intersects the sphere, are in a horizontal plane.

The cutting tool has a solid body and is U-shaped at the cutting end. Two round carboloy blades or discs are used. Each blade is held by a clamp, which also acts as a chip breaker. Size is controlled within 0.001-inch by the depth of feed, set by an adjustable stop. On a 1¼-inch diameter ball stud approximately 0.060 inch of stock is removed in a 15-second floor-to-floor cycle. Generated finish is 40-60 microinches rms. Total error in sphericity is held at 0.0005 inch. After the cutting operation, the ball is honed to generate final geometric accuracy, size, and surface finish. The part is located and held in the

"In modern manufacturing, electrical control equipment is the very heart of mechanized and automatic operation. Because our plants have become so dependent on this equipment, the cost of 'down time' for any control failure is simply staggering. And, according to many manufacturing engineers, limit switches are the worst offenders, accounting for as much as 70% of all interruptions due to control failures."

Mr. J. S. Wilford, Editor
PRODUCTION Magazine

"At least 60% of the electrical failures causing downtime of the production machinery used in manufacturing home appliances at the Whirlpool Corporation can be traced to faulty limit switch operation. An analysis of the switch failures reveals the inability of limit switches to meet the requirements of high production equipment such as is widely used in our St. Joseph Division."

Mr. C. R. Burg, Maintenance Engineer,
Whirlpool Corporation

"75% of the electrical failures on our machines can be traced directly to limit switch malfunctions. This problem is particularly aggravating to us because we are responsible for the successful operation of our machines and their components on our customer's floor. We have spent a great deal of time engineering protective mounting schemes to compensate for the inability of today's limit switches to check the seepage of corrosive coolants and microscopic grit."

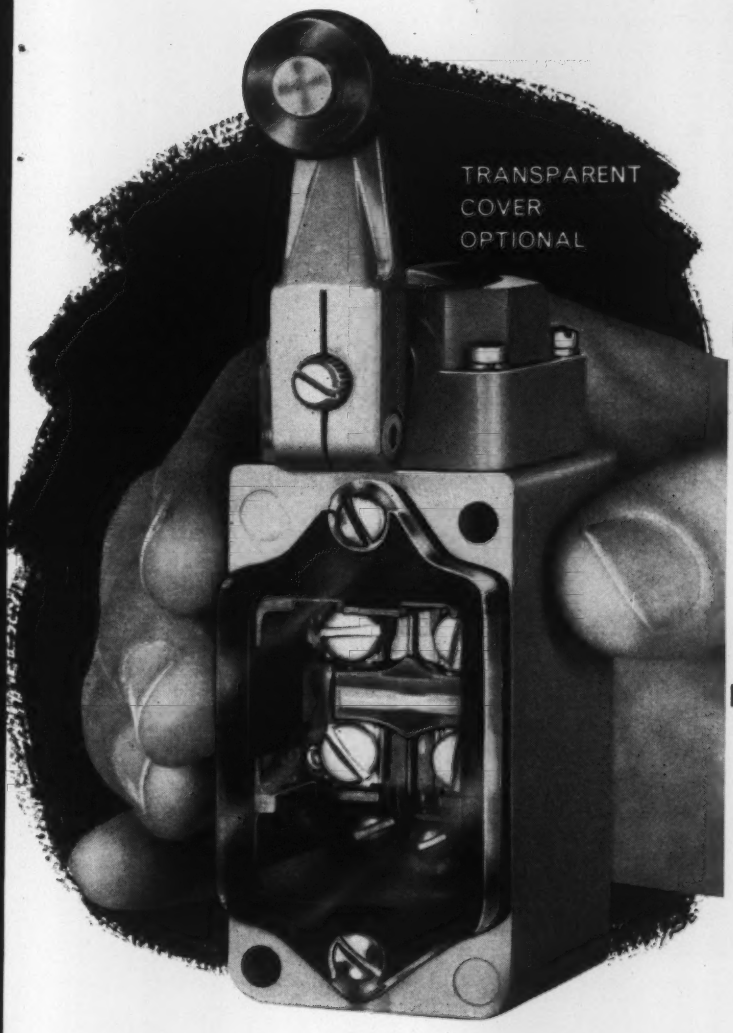
Mr. N. P. Bashor,
Director Electrical Division,
W. F. & John Barnes Company

Production's Enemy #1 MEETS ITS MASTER

Cutler-Hammer announces the *first*

- ***Tolerance Compensated***
- ***Contamination-proof***
- ***Visible Contact***

Extended Life Limit Switch



■ *Tolerance Compensation*

The new Cutler-Hammer Extended Life Limit Switch represents a startling break-through in high-precision manufacturing methods. Each sub-assembly is accurately calibrated so that in final assembly all plus and minus tolerances are precision balanced or compensated. Thus, tolerance compensation guarantees every C-H Extended Life Limit Switch will operate identically with precise repeat accuracy and ultra-long life. No binding . . . no sticking . . . no points of concentrated stress or wear.

■ *Contamination-proof*

New triple sealing positively checks seepage of all forms of oil, coolants, moisture, and abrasive grit. New cone-seal stops seepage through the operating shaft bearing. New vulcanized bellows-seal between the operating head and body eliminate the troublesome "O-ring" seal . . . won't wear . . . never needs attention. New cover seal seats on a raised lip . . . repeated opening and closing of the cover won't destroy the seal. Total-submersion life tests prove the new C-H Extended Life Limit Switch to be contamination-proof . . . suitable for even dry circuit applications.

■ *Visible Contacts*

Another Cutler-Hammer *first* . . . this new Cutler-Hammer Limit Switch provides completely enclosed but *visible* single pole double throw switch contacts. During installation, one glance shows which contacts are open and which are closed . . . no chance for wiring errors. During operations, one glance proves whether the switch is set and operating correctly. Positive visible inspection cuts maintenance costs too.

Compare these features, too!

- **One basic model is readily adapted to all desired forms of lever or plunger actuation . . . for either momentary or maintained contacts . . . for either surface or cavity mounting.**
- **Unsurpassed flexibility: 90° orientation of the operating head. 360° rotation of lever arm with a locking device that holds the adjustment. Lever operators provide clockwise, counter-clockwise, and clockwise-counter-clockwise actuation . . . easy to set on the job without disassembling the switch.**
- **Precise actuation . . . 10° pretravel—40° overtravel or 5° pretravel—45° overtravel.**
- **Visible, saddle-clamp terminals . . . no loose fibre flash-over barriers.**
- **Unitized switch mechanisms are interchangeable . . . speeds replacements when overload or short circuit damage occurs.**
- **Meets all JIC and NMTBA requirements. Easy, complete interchangeability with any widely used limit switch.**

The new Cutler-Hammer Extended Life Limit Switch installs easier, works better, and lasts longer than any of the "oil-tight" limit switches now in use. Exhaustive tests, including total-submersion life tests, confirm this fact! But don't take our word for it. Try it . . . Test it . . . Compare it. The new Cutler-Hammer Extended Life Limit Switch is completely interchangeable with any widely used limit switch. Replace your *most* troublesome limit switch installation with this new tolerance compensated, contamination-proof, visible contact Cutler-Hammer Limit Switch; and it will work better, last longer than any other you have ever used. This is the answer to your limit switch problems.

For descriptive data write for Publication ED143-E283. Cutler-Hammer, Inc., Milwaukee 1, Wisconsin.

H CONTROL

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

Circle 688 on Page 19

same manner as for the cutting operation. The combination of rotating motions of the workpiece and the special honing tool gives a crosshatch lay pattern and makes the abrasive self-dressing. In a 24-second floor-to-floor cycle, a final 0.002 inch of stock is removed from 1¼-inch diameter balls, generating a finish of 6-10 microinches rms, and sphericity within 0.0003 inch. **Micromatic Hone Corp.**, 8100 Schoolcraft Ave., Detroit 38, Mich.

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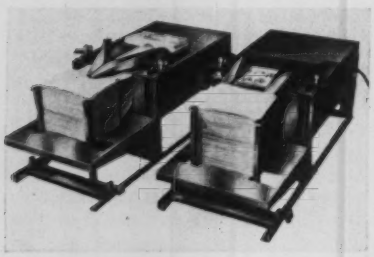
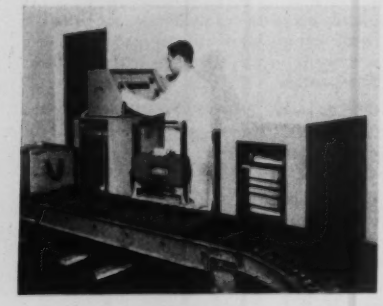


Bag Magazine

Magazine for high-speed bagging machine features a rise and fall principle that elevates the magazine platform automatically as bags are filled and removed for closure. It can be used for polyethylene or paper bags of any size. In operation, as soon as one package is removed, the next bag is automatically positioned for filling. The top bag is blown open by a jet of air. **Tele-Sonic Packaging Corp.**, 208 W. 27th St., New York 1, N. Y.

Circle 410 on Page 19



Conveyor Routing System

Automatic conveyor routing system directs tote boxes, cardboard cartons, and other containers to packing stations for broken lot order assembly; or to direct work through various processing stations. Model 450 is designed so the container can be diverted at any station, processed, placed back on the conveyor and diverted again at another station for further processing. The routing system is controlled by a dispatcher at the control console. He selects the routes by depressing station keys and the coded instructions are automatically placed on the container by an inking printer. Code reading carton selectors accurately control the direction of flow. If the container is to be re-used, the code can be automatically removed by optional equipment following the last station. **Atronic Products Inc.**, One Bala Ave., Bala-Cynwyd, Pa.

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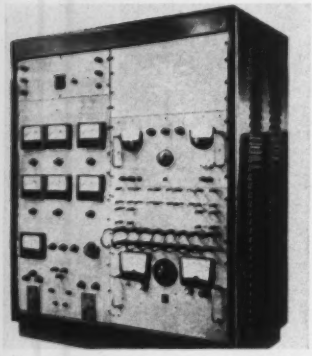
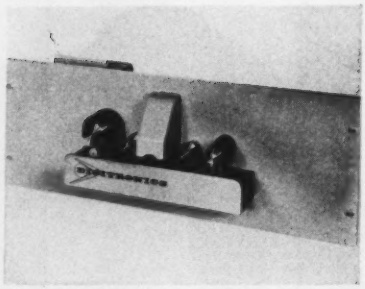


Transistor Test System

Power transistor test system is applicable for production, quality control, and receiving inspection operations. Model PTT-1 is housed in two 42-inch enclosed relay racks which are mounted side by side. The system provides complete dc characterization of power transistors from micro amperes to 20 amperes. Readout of breakdown voltages, emitter floating potential, saturation voltage measurements, and simultaneous display of input and output voltages and currents is provided on precision panel meters. Special systems can be supplied with automatic readout on punched tape, punched cards, and magnetic tape. **Inter Mountain Instruments Branch, Electronics Div., Curtiss-Wright Corp.**, P. O. Box 8324, Albuquerque, N. M.

Circle 412 on Page 19



Punched Tape Reader

Transistorized punched paper tape reader stops before the next character at reading speeds of 1000 characters per second. Silicon photodiodes are used to provide stability over wide temperature ranges. Model 3500 can handle 5, 6, 7, or 8-level tapes by setting the tape guides. Both dual and single speed units are available. Various stages of amplification are also available for both input control signals and output data signals. Tape motion can be controlled by either a dc or pulse input. Power requirements are 115 v, 60 cps, 180 w. **Dykor Tape Reader Div., Digitronics Corp.**, Albertson, L. I., N. Y.

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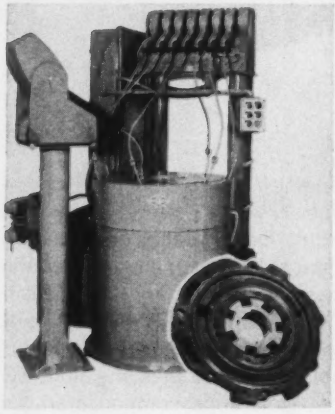
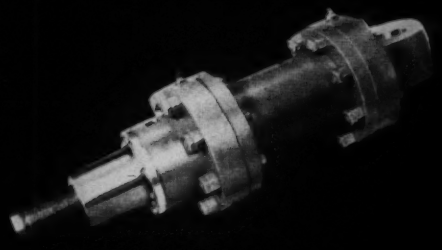


Pump Assembler

Machine automatically assembles vane-type pumps from parts including springs, slippers or vanes, rotor, and pump body. The operator loads rotors and cycles the machine. Linkage-operated devices feed seven springs and seven vanes. The machine operator then cycles the stripper which strips the completed

Here is power cylinder engineering when you need it!



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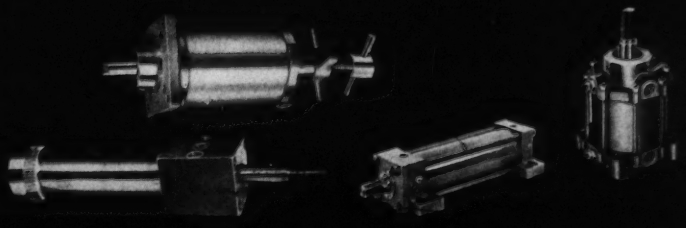

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The Wellman Engineering Co.
2723 Connor St., Port Huron, Mich., U.S.A.

Please send me more information about Anker-Holth Cylinders C-5

Name_____

Title_____

Company_____

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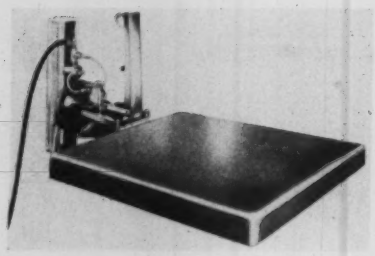
Circle 689 on Page 19

rotor assembly into the pump body. The springs hold it in place. Production rate is 300 pumps assembled per hour. **Gray Equipment Co.**, 13600 Ford Rd., Dearborn, Mich.

Circle 414 on Page 19



Carton Stapler

Equipment drives staple clips at the rate of 400 per minute, closing filled cartons from the outside. It features an automatic mechanical trip which clenches the staple and instantaneously retracts ready to drive the next staple. Model T-P staples A, B, or C flute corrugated board. A twist of the adjustor screw automatically controls the clip for any thickness. The diaphragm chamber requires no lubrication; has only one moving part which develops no friction. Moving parts are treated with molybdenum disulfide which prevents seizing and galling at bearing pressures over 100,000 psi. **Container Stapling Corp.**, 27th St. & I.C.R.R., Herrin, Ill.

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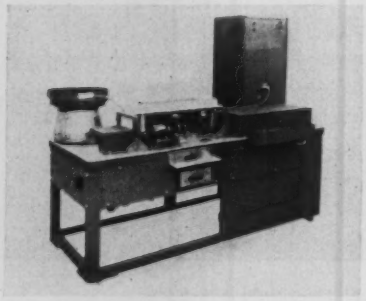

Spiraling Lathe

Machine is used for producing and testing film type resistors to a predetermined electrical value over a resistance range of from 10 ohms to 10 megohms. Accuracy is dependent on variables such as speed of machine, physical size of resistor, electrical value, and type of film used. In operation, parts to be spiraled are bulk fed into the vibratory bowl type feeder of Model ABL-6. This feeder is coated with a special plastic material to minimize abrasion. Resistors then automatically proceed via a feed tube to an escapement device which inserts the units one at a time into the chucks of the lathe. A rapid advance is provided to move the units up to the cutting wheel, at which time the carriage of the lathe proceeds with its normal forward stroke. As the units are spiraled to the predetermined electrical value, a fast retract stroke is provided. A sensitive automatic bridge monitors the resistors throughout the spiraling cycle. **Industrial Instruments Automation Corp.**, 89 Commerce Rd., Cedar Grove, N. J.

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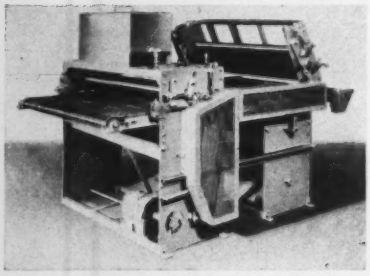

Roller Coater

Model CG is suitable for use with materials or compounds of high viscosity. Method of applying materials or compounds to the rolls is by ironing them onto the applicator roll. When extra heavy coatings are required, or when a conditioner must be applied before the final coating is applied, the coaters can be used in tandem (as shown in the photo). The work is fed into the first roller coater by a conveyor. The conveyor between the first and second roller coaters feeds the work into the second unit and provides a setting time for the first coat before application of the second coat. Feature of the coater is that the upper applicator roll is hinge-mounted so it can be easily opened for cleaning. **Murray-Way Corp.**, P. O. Box 180, Birmingham, Mich.

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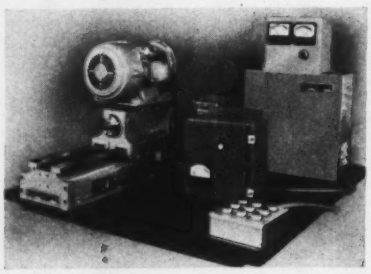

Deep Hole Drilling Unit

Suitable for machining soft metals like aluminum, "building-block" unit is composed of six components —deep hole drilling unit, spindle load meter, feed rate meter, spindle tachometer, electrical control cabinet, and control panel. The spindle load meter can detect variations in the workpiece, such as density, heat treatment; condition of the tool; and whether the chip and coolant systems are functioning properly. Spindle speeds up to 10,000 rpm can be obtained with any combination of feed rates from 0.0001 to 0.025 inch per revolution. Mechanical models have strokes up to 60 inches; hydraulic models are available with strokes up to 24 inches. **Drillmation Co. Inc.**, 6500 E. Eleven Mile Rd., Center Line, Mich.

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Twin-Spindle Grinder

Automatic, twin-spindle, high-speed grinder can simultaneously deburr and chamfer the entire contour of both ends of spur, helical, or bevel gear teeth. The grinder drives reinforced wheels at 17,000 rpm with standard air spindles. Spindles rotate in directions to pre-

At long production lines or individual work stations...

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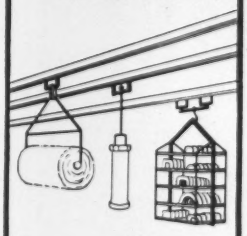
CONTINUOUS POWER
CONVEYORS will save you TIME, LABOR and DOLLARS!

From electronic devices and TV Tubes that require "gentle" handling to wearing apparel, foods and rugged industrial products—an R-W "Zig-Zag" Conveyor offers a time and cost saving overhead materials handling system. Equally adaptable for small, special purpose conveyors or huge "door-to-door" plant-wide systems that convey components and products from receiving, through all production processes, finishing operations and on to shipping. "Zig-Zag" Conveyors offer a time-proven method of increasing production and lowering overall manufacturing costs.

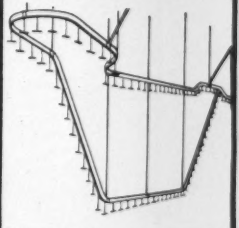
CHECK THESE IMPORTANT "Zig-Zag" ADVANTAGES AND FEATURES

VERSATILE



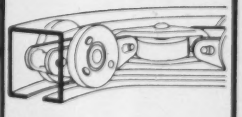
... applicable to industrial plants, warehouses and commercial operations of all types and sizes—no matter how large or small. Efficiently conveys unit loads up to 125 lbs. of products, parts, components, etc. at speeds of one inch to 100 feet per minute ... the only conveyor offering a *proven* multi-speed drive unit.

FLEXIBLE



... in fact, the most flexible conveyor in its class. May be installed to move up, down, in, out and around. Ideal for all types of overhead materials handling ... efficiently and economically conveys products from receiving, to inventory through all production processes, finishing and finally to shipping. Saves time and costs "all the way."

RUGGED

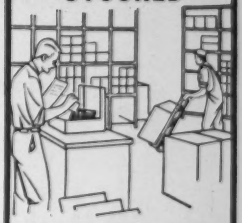


... furnished in one, top-quality grade ... inferior components are never substituted. "Zig-Zag" consists of a continuous chain of alternate horizontal and vertical wheel units which travels through a rugged steel track. Chain, track, power units and accessories are all "designed for each other" for years of dependable service and trouble-free operation.

RE-USABLE

... "Zig-Zag" systems may be changed, expanded or relocated with almost 100% reusability. Economical to purchase and install ... plant personnel can easily "self-assemble," install and later relocate a "Zig-Zag" System. "Zig-Zag" will meet your needs now—and for years to come. May be later incorporated into an R-W "Twin-Trak" Automatic Dispatch System.

STOCKED



... in most metropolitan areas. Permits *immediate* shipment of all components for your "Zig-Zag" system. When necessary a complete system can be installed and operating in a matter of days. R-W's nation wide staff of factory trained, materials handling specialists are near by to take care of any service that may be necessary ... eliminates unnecessary downtime.

An R-W Sales-Engineer, at no obligation, will gladly survey your plans or facilities and submit a plan showing how "Zig-Zag" will best solve your materials handling problems. Write today for complete information.

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Circle 690 on Page 19

vent wheels from digging in. In operation, the gear is placed on the fixture, and two *Start* buttons are pressed to begin the machine cycle. The fixture starts rotating and tilts upward. Grinding-wheel spindles lower to contact the work and deburring starts. After a preset number of rotations of the gear during which the grinding wheels rise and fall (to follow the contour of the heel and toe), the spindles automatically are raised, the fixture is lowered to unload position, and fixture rotation is stopped. The number of rotations of the gear is determined by the depth of chamfer desired and the amount of material to be removed. Cycle time set on the adjustable timer is determined by the number of rotations required, the pitch of the gear and its size. Cycles vary from 20 to 60 seconds per gear. **Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit 12, Mich.

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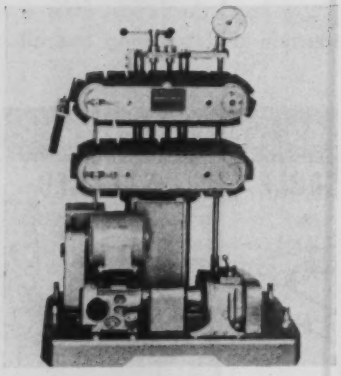

Take-Off Machine

Featuring a belt-traction system, take-off machine can be used with any type of extruded tube or profile. It provides a nonslip grip over a wide area of contact, sandwiching the profile between resilient pads mounted on two belts running at identical speeds. The contact pressure of the pads is light, so no distortion can take place. Various speed ranges are furnished between the limits of zero to 500 fpm. Machine is available in two models for handling extrusion diameters from zero to 8 inches and zero to 16 inches. **Farris Universal Machine Corp.**, 448 Commercial Ave., Palisades Park, N. J.

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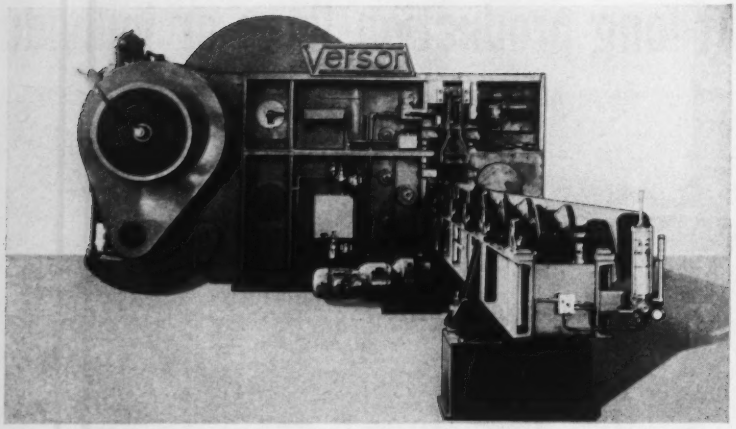

Heavy Duty Bar Billet Shear

Machine has a capacity to shear 4-inch R.C.S. SAE 5140, 115,000 tensile strength bars. It is rated at 700 tons, 1.9-inch up at point of shear. Production rate is 32 strokes per minute with a 4-inch stroke at point of shear. It will shear billets up to 6 inches long at this speed or billets 8 inches long at 25 strokes per minute. Weight of sheared billets is held to a tolerance of ±3 ounces. Shear cut length tolerance is ±0.020-inch. Features of the unit include: Power feed conveyor, length gage, outboard support, hold down, and automatic lubrication. Operating conditions can be selected to provide continuous operation, single stroke-automatic, once-automatic, once shear only, and inch-shear only. **Verson Allsteel Press Co.**, 9300 S. Kenwood Ave., Chicago 19, Ill.

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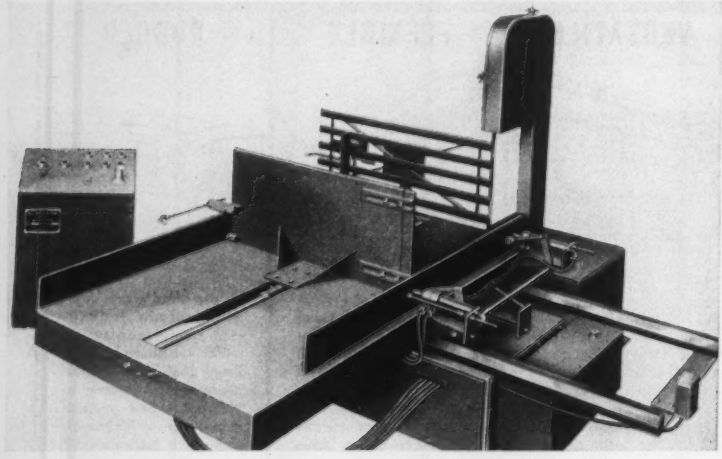

Automatic Saw for Cardboard and Wood

Automatic band saw is designed for cutting cardboard and wood, can handle sheets up to 4 by 5 ft, 20 inches thick, with slices taken from the 4 ft end. In operation, a rolling table carries the work across the blade at a rate of travel set by the operator. It returns on rapid traverse. The clamps release, and the work is advanced and reclamped. The cycle automatically repeats until the last cut is made. Then the machine returns to starting position, where the clamp and feed mechanism open for reloading. Model 0-50 can be run at a rate of four cycles per minute. **W. F. Wells & Sons**, Three Rivers, Mich.

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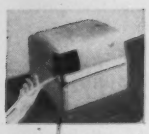
Teletype machines help cut costly paperwork

A Teletype machine equipped with a simple sprocket-feed mechanism can handle multi-carbon forms as readily as the more familiar plain paper on which messages are transmitted. Thus distances can be bridged not only with information, but with information that is preprocessed, ready to go to work.

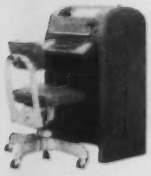
Teletype printers handle a wide variety of multi-copy forms. Moreover, the usefulness of this technique can be further extended with Teletype tape punching and reading equipment—which can capture, store and utilize repetitive data to further mechanize paperwork procedures.

For more information about Teletype Model 28 equipment, please write to Teletype Corporation, Dept. 25C. 4100 Fullerton Ave., Chicago 39, Illinois.



Typing Tape Punch

Tape Reader



Send-Receive Page Printer

Automatic Send-Receive Set

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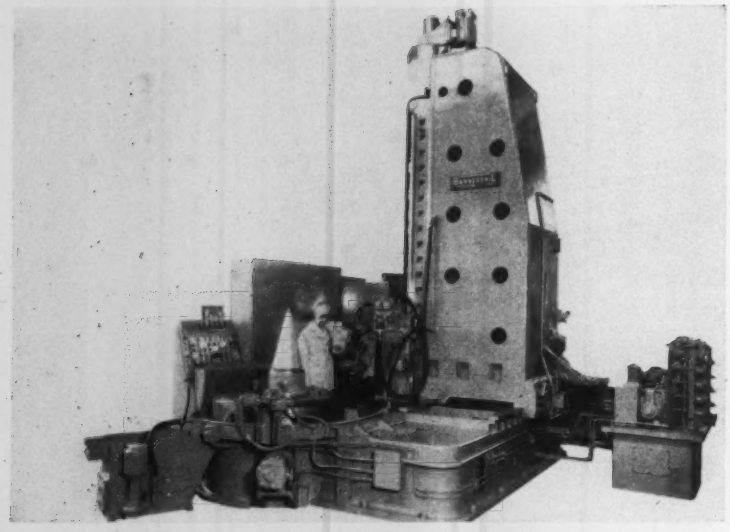

Numerically Controlled Drilling Machine

Four-motion programming machine can perform combination drilling and countersinking, combination drilling and counterboring, straight drilling, reaming counterboring, countersinking, and tapping. It can drill and tap cylindrical sections with maximum diameters of 36 inches and maximum height of 72 inches, conical sections and curves with a configuration not exceeding ±15 degrees off horizontal center. The horizontal drilling unit employs vertical spindle movement with air counterbalance, in and out column travel movement of 24 inches, and a rotary table 40 inches in diameter for positioning the part being machined.

The rotary table motion, which is powered by a ¾ hp motor, can be indexed through 360 degrees from the given reference point at a speed of 1.25 rpm. Features of the table are a lifting mechanism for rotation and a clamping arrangement for locking the table when the desired position is reached. The controls on the machine perform the auxiliary functions of supplying instructions for machine and for the operator. Instruction lights on the control panel automatically indicate when tool changes are required for different operations being performed. The machine will not function unless the proper tool is in the spindle and all other tools are correctly located in the 6-position tool board. A special sensing device senses the depth of the tool from the face of the work. Positioning of the machine motions, as well as the operator and machine instructions are done simultaneously from information punched on 8-channel tape. When all conditions set up on the tape have been satisfied, the control supplies a signal to the machine which starts the machine function after the rotary position has been automatically checked. When all holes in one row have been completed, the tape positions the spindle vertically, rotates the table, and moves the column in position for the next row of holes. **Barnes Drill Co.**, 836 Chestnut St., Rockford, Ill.

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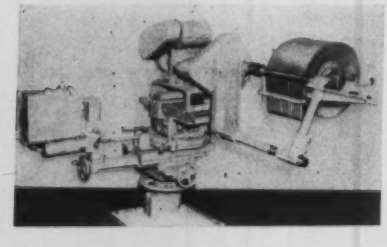

Buffing Manipulator

Machine is designed to handle parts for buffing or polishing that have obstructions, such as coffee pots with spouts, ratchet-type wrench heads with handles, and stampings or die castings with radius portions. The machine is equipped with an air cylinder advance and an oscillating arm fixture. Parts can be mounted on an arbor with a locator and square drive. Then the arbor and part assembly are positioned in the oscillating-arm unit by an air-powered tailstock. When the parts are positioned in the arm, they are advanced by an air cylinder control into contact with a buffing wheel on a conventional buffing lathe or an adjustable lathe. A pushbutton initiates a timed sequence of arm oscillation to give the desired wheel contact time. The oscillating arm unit can be adjusted to give from zero to 360 degrees of oscillation. Two machines, like the one shown, finish 600 wrench heads per hour with one operator. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

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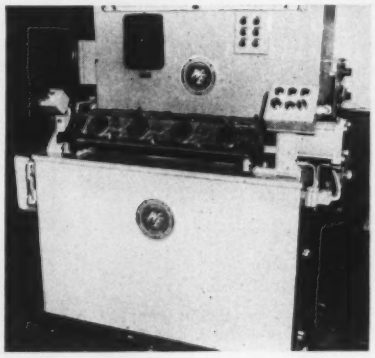

Test Stand

Pneumatic test stand can perform two tests on ⅜ inch diameter high pressure oil holes that run the full length of the head. These holes feed the fuel injectors in a diesel engine. Testing rate is 60 pieces per hour. The first test is a shock test at 500 psi to check for poor casting structure (the normal operating hydraulic pressure in the head is 250 psi). The second test is to inspect the holes for individual leaks or sequence the test so each hole is tested separately, at 20 psi. The tests, pressures, times, accuracies, sequence, and holding fixture are adjustable to handle different parts such as transmission cases, V-8 cylinder blocks and heads, and manifolds. **Wilson Engineering Inc.**, 400 Florence St., P. O. Box 7, Saginaw, Mich.

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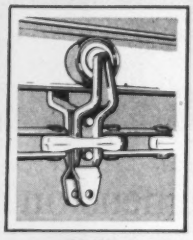
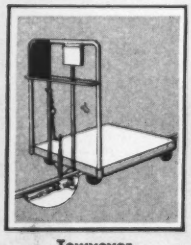
EVER MEET THE FAMILY?


Trolley

Power & Free

Automation


Towveyor

The Jervis B. Webb Company is in its 40th year of designing, manufacturing and installing custom engineered conveyor systems. We have also acquired a fine family of diversified industries that complement each other to provide complete customer service.

Each member of the family is a separate organization with highly skilled personnel who specialize in designing, manufacturing and installing: cranes and monorail systems; bulk handling systems; universal test equipment; and close tolerance forgings. End products differ, but the prime objective is the same—better production at lower cost.

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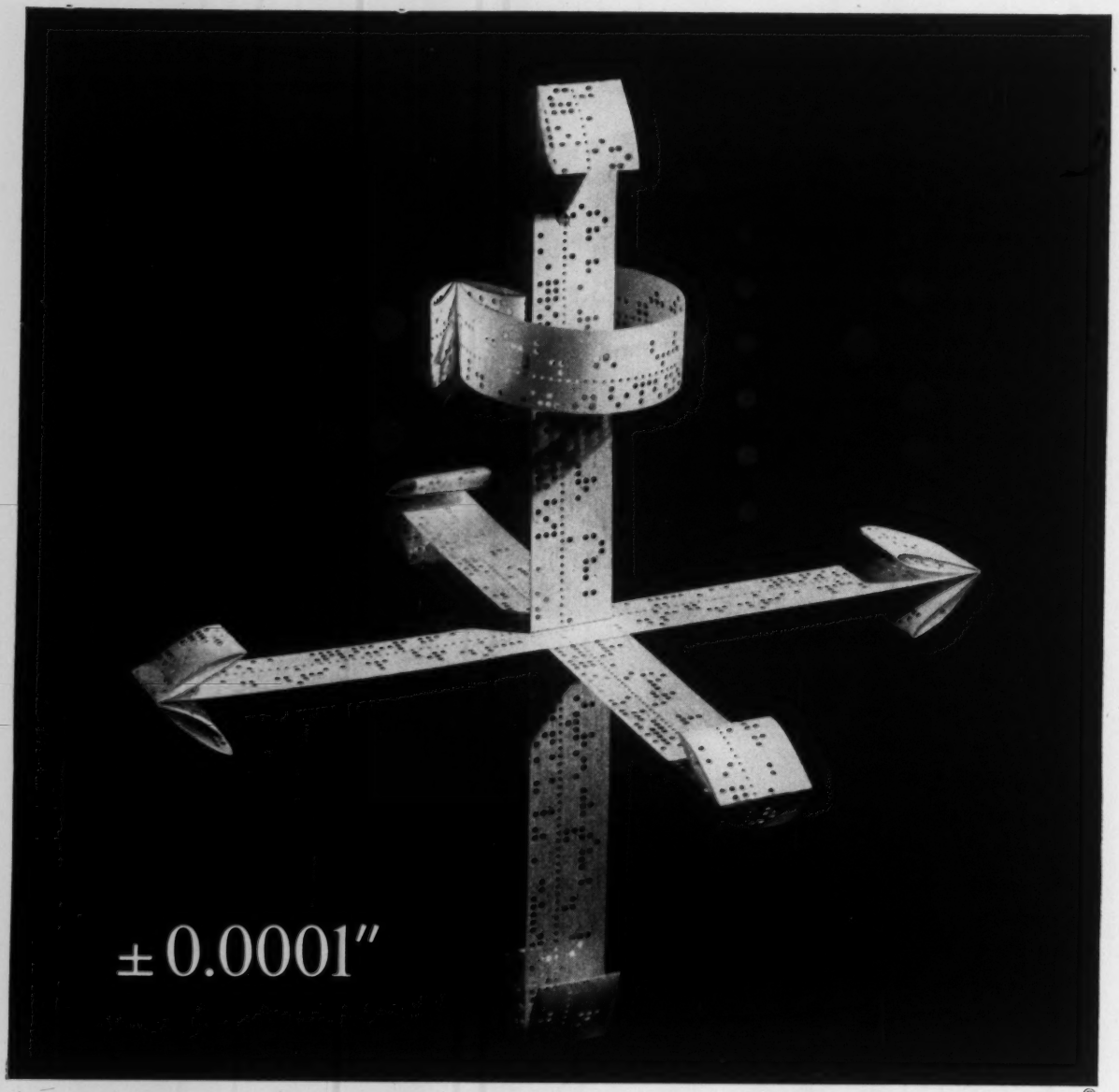
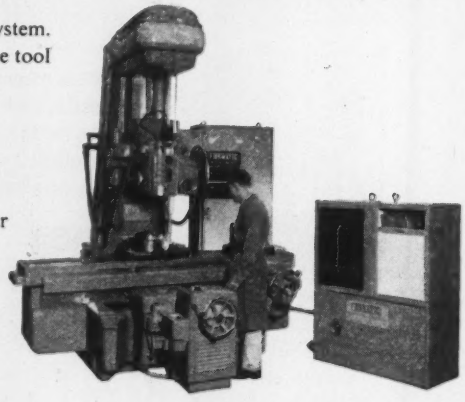
Circle 692 on Page 19



PRECISION BORING: Control gains a Third Dimension!

Now Fosdick adds Numerical Depth Control to its unique positioning system. Another loophole for error in precision boring has disappeared. Watch the tool drive smoothly to depth, boring a hole with finer finish, precise in depth and location. Watch the tool advance and retract quickly, saving time. *Tape or dial any depth. Absolutely no stops to preset.*

See how this control signals every tool change and compensates for tools of random length. It was planned when the Fosmatic precision boring machines were designed, so that it fits and takes no extra space. Consider what this new dimension in control means to your critical production jobs. Write for catalog PB-W.



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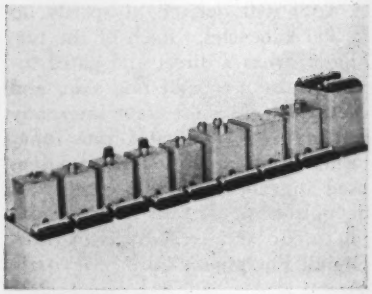
Cincinnati 23, Ohio

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.



Static Regulator Modules

Line of static regulator modules is suitable for the control of motor or generator fields, speed regulators, current regulators, time rate, or current limit control. The types of modules in the line are: Adjustable time reference unit; power supply; reference regulator; 15 v comparator; 30 v comparator; power amplifier; cross-over unit; adjustable current limit unit; low level current amplifier; and 6 v bias supply. **Cutler-Hammer Inc.**, 378 North 12th St., Milwaukee, Wis.

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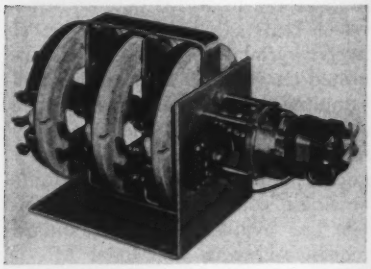

Motorized Rheostat

Motor-driven rheostats or variable transformers can be used in remote control applications or where a predetermined rate of resistance or voltage change must be smoothly achieved. Drive consists of a motor with integral gear reducer and cam-operated limit switches which accomplish reversal of the control. Also available are motor-driven assemblies of ganged transformers or rheostats, combinations of large and small rheostats, large and small transformers, transformers and rheostats, and rheostats and tap switches. **Ohmite Mfg. Co.**, 3677 Howard St., Skokie, Ill.

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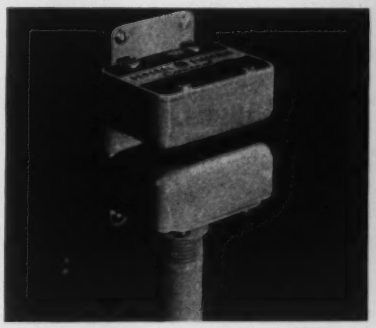


Limit Switch

Vane-operated limit switch can be used to control machinery travel. It is available in either front or top operated models, normally open or normally closed, single-pole contacts, with or without an indicating light. Magnetic device is energized by the passage of a separate metal vane through a recessed slot in the switch. Attached to the mechanism to be controlled, the vane disturbs a magnetic field balance which causes hermetically sealed contacts to operate. Operation is consistent within ±0.0025 inch, providing the path of the vane is maintained. Response time of the switch is approximately 0.001 second. Switch is rated for 115 v ac, 0.2 amp make or break. **General Electric Co.**, Schenectady 5, N. Y.

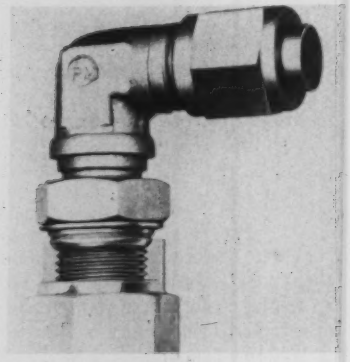
Circle 428 on Page 19

Digital Encoder

Shaft-position digital encoder has a 13 bit binary output and is applicable in digital control and data logging equipment. Model EP-13B features a noncontacting magnetic readout, will operate at speeds up to 10,000 rpm. The parallel output is in binary code and total count is reached with 64 turns of the input shaft. The readout method employs subminiature, ferrite toroids mounted above code tracks of magnetized spots on barium ferrite discs. In operation, as a toroid readout head enters the magnetic field of the code spot, it saturates and its impedance drops. When the head is interrogated by a con-

stant current pulse train, an output is obtained only when the head is unsaturated (outside the influence of a code spot). **Ascop, Div., Electro-mechanical Research Inc.**, P. O. Box 44, Princeton, N. J.

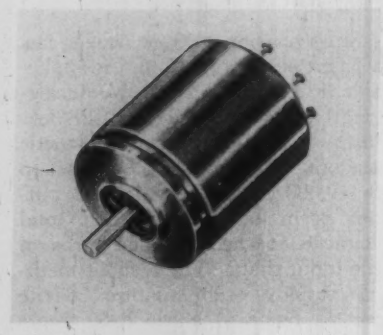
Circle 429 on Page 19



Tube Fitting

Securing tube fittings to port bosses by means of a metal seal is a suitable method wherever temperature or corrosive conditions exist. The illustrated port fitting is provided with a metal seal in place of O-rings. It is available in sizes from 1/4 through 2 inches OD. The seal can be used on pressures from 28 inch vacuum through 5000 psi under temperature variations from −270 through 1200 F. The fitting can be placed in any position and it will not loosen by vibration or thermo shock. **Paragon Mfg. Corp.**, 1179 E. 134th St., Cleveland 10, Ohio.

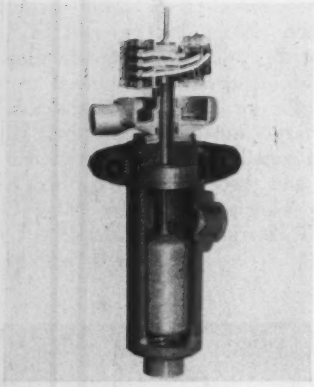
Circle 430 on Page 19



Frequency Generator

Unit is a miniature permanent-magnet rotor type generator that provides a two-phase ac output voltage. The voltage amplitude and frequency vary in direct proportion to the shaft speed. Model 3200 can be used as a reference generator to provide information on the rotational speed and angular position of a shaft (as in constant-velocity servo systems). It can also be used for circular sweep generation on a CRT, utilizing the two-phase output phase relationship, to position the beam on the scope face as an instantaneous function of generator shaft position. Driving torque is 0.005 oz-in. maximum at 3000 rpm under rated load; impedance, 300 ohms per phase at 3600 rpm. **Cedar Engineering, Div., Control Data Corp.**, 5806 W. 36th St., Minneapolis 16, Minn.

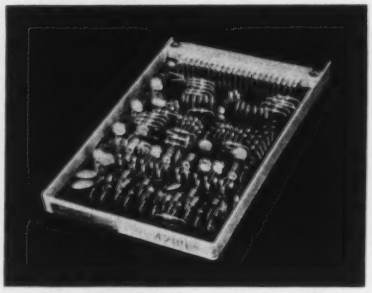
Circle 431 on Page 19



Liquid Level Control

All parts of the liquid level control which come in contact with liquids or vapors are of non-metallic material. The control is corrosive resistant, immune to galvanic or electrolytic attack; immune to oxidizing agents; and will not contaminate or impart odors or tastes to the liquid. It can control any liquid of specific gravity 0.70 or above. Chamber and float construction are for service at 100 psi at 70 F, or 50 psi at 140 F. Control is available in two styles. Model NM-1 is an external float cage unit with a sealed body and float totally enclosed. Model NM-2 (shown) is a flanged style chamber unit, with head flange secured to the chamber. **Magnetrol Inc.**, 2110 S. Marshall Blvd., Chicago, Ill.

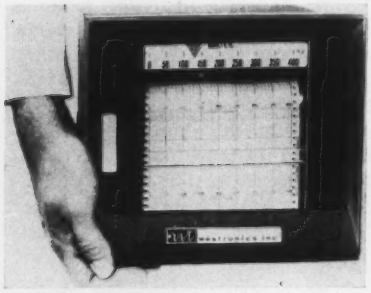
Circle 432 on Page 19



Dual Flip-Flop

Device contains two identical flip-flops with built-in output amplifiers, is designed to provide flip-flops in buffer and control registers. Model 4209 will operate at speeds up to 500 kilocycles. Each of the two flip-flops has a direct and gated input to the zero and one side, and each has one pulse gate internally connected to the gated one input terminal. The static-type flip-flops used in this unit have continuous dc output signals, so actions need not occur at any fixed clock rate. **Digital Equipment Corp.**, Maynard, Mass.

Circle 433 on Page 19



Multipoint Recorder

Miniature, multipoint strip chart recorder is a recording potentiometer which will allow the plotting of twelve variables on a five inch calibrated chart width by scanning and sampling. Each variable is identified at its position on the chart by means of a number, or a number and a point, printing with multiple or single colors. Six different colors are available on a standard model. Feature of Model M5 is the separate chart reroll motor and clutch assembly which allows the used chart to be pulled out for inspection and then automatically rerolled. Accuracy of the recorder is

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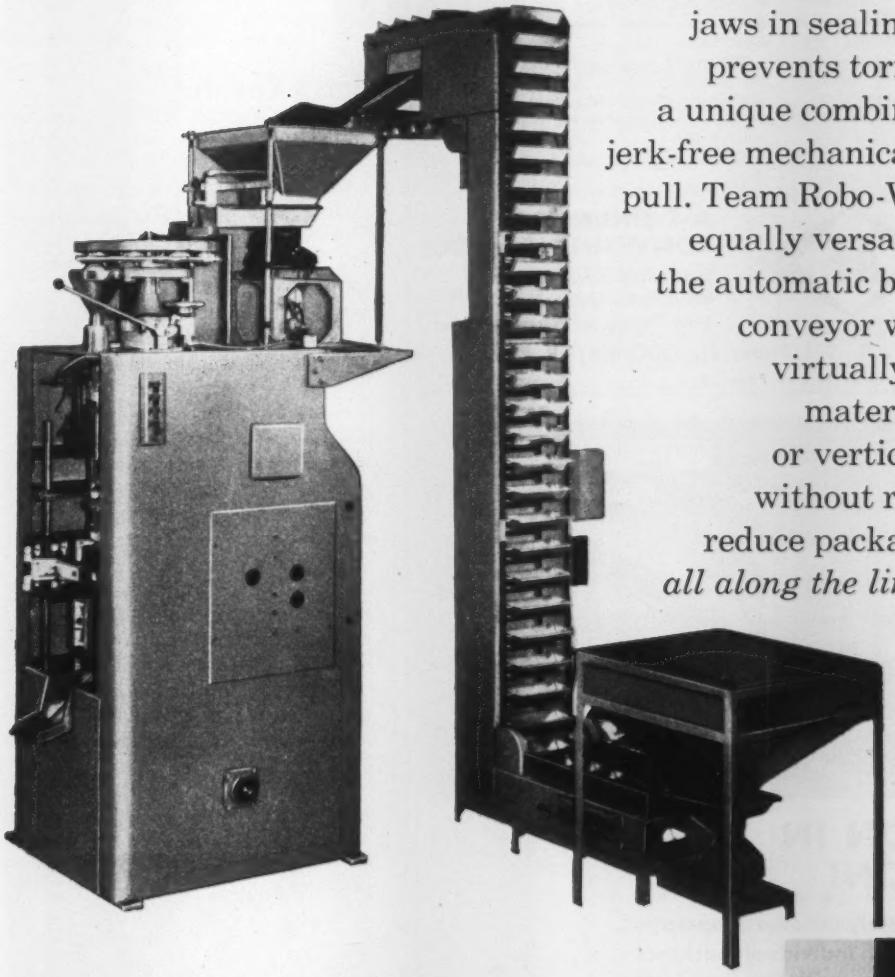
Liquids, powders, solids, granules: Robo-Wrap versatility forms, seals and fills up to 120 poly, cello, paper, plastic or laminate pillow packs per minute, with a reject rate that's negligible. New standards of sealing . . . an amazingly low down time record is being set by Robo-Wrap in the most demanding and highly automated installations throughout the country: the result of still another Lynch engineering advance—the unique hand-over-hand action which holds jaws in sealing position longer, prevents torn roll stock with a unique combination of strong, jerk-free mechanical and hydraulic pull. Team Robo-Wrap with the equally versatile Robo-*Lift*—the automatic bucket elevating conveyor which moves virtually any free-flowing material horizontally or vertically, gently and without re-handling—to reduce packaging costs *all along the line.*



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Circle 694 on Page 19

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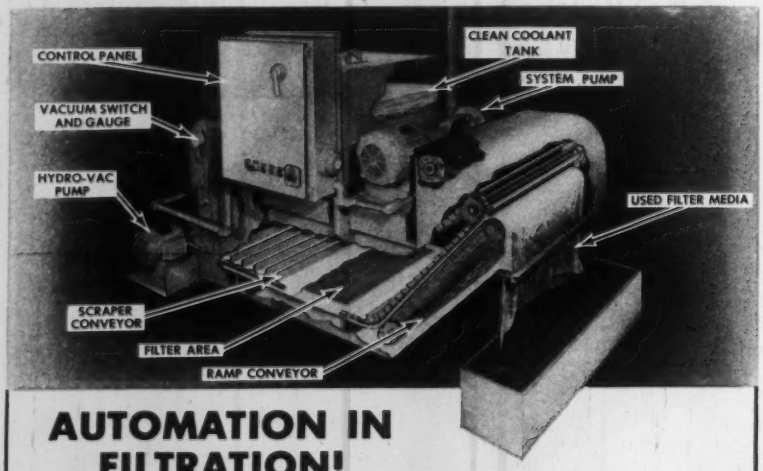
Circle 695 on Page 19



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- Fine degree of filtration
- Pressure and vacuum forces act on filter media
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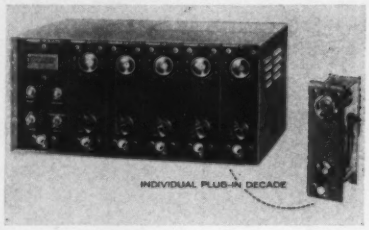
Circle 696 on Page 19

±0.5 per cent of full span; sensitivity, 0.15 per cent of full span; hysteresis, 0.3 per cent of full span. It will operate on 115 v ac, 60 cps, 65 w. **Westronics Inc.**, 3605 McCart St., Fort Worth 10, Tex.

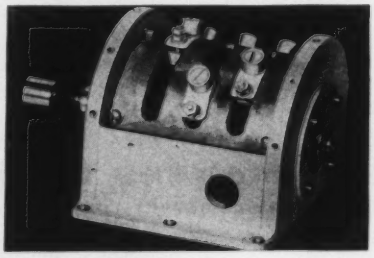
Circle 434 on Page 19



Batch Counter

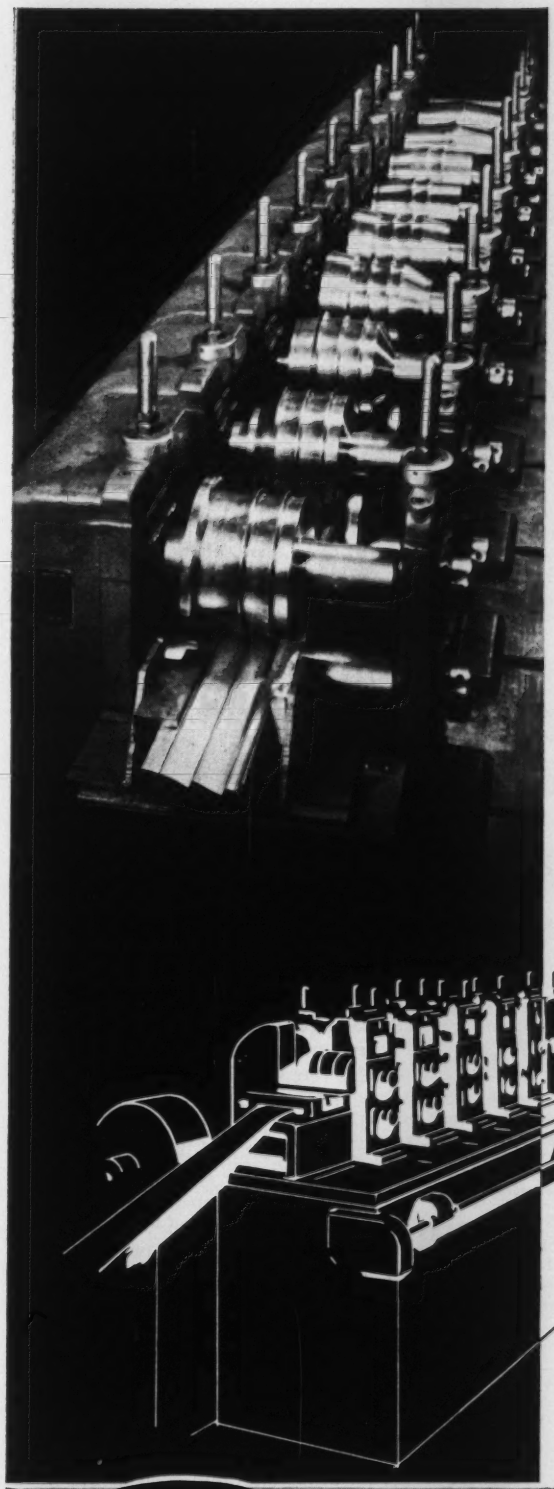
Electronic batch counter, designated Tally-Count, can handle all types of batch counting, machine cycling, and packaging operations. Counting capacity is up to 100,000. Features of the unit include remote control operation and automatic zero set. Counter is available with a wide range of plug-in sensing devices such as warning presets which furnish warning signals before the final count is reached and photoelectric amplifiers which convert photoelectric signals into counting pulses at speeds up to 100 per second. Other sensing devices available are photoelectric sensing units which count and inspect production parts without contacting the material controlled and a footage-yardage counter for control of material length in applications for coil winding, roll fed printing, and textile weaving. **Standard Instrument Corp.**, 657 Broadway, New York 12, N. Y.

Circle 435 on Page 19



Rotary Switch

Unit is designed for controlling automatic cycling equipment such

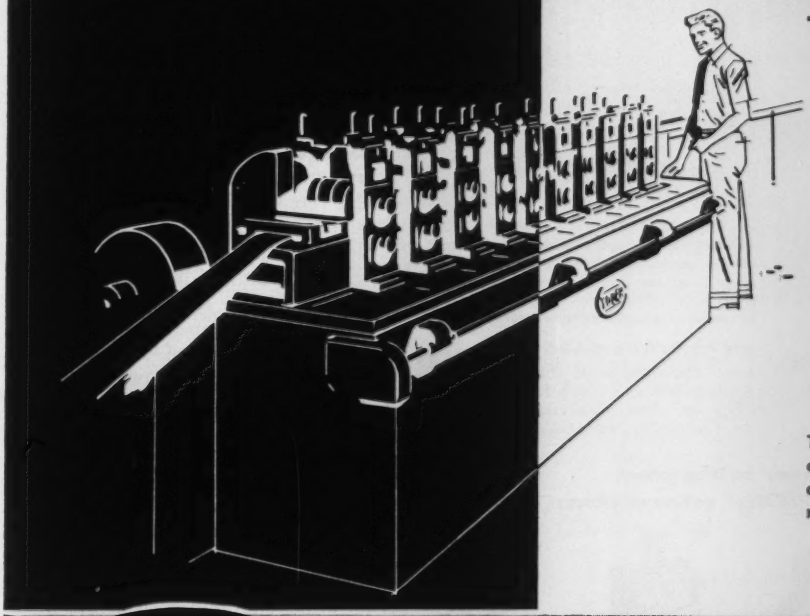


Yoder Roll-Forming Equipment mass-produces shapes accurately, economically

Yoder Roll-Forming Equipment, even with part-time operation, can effect significant savings in many metal working applications and industries. Shapes, simple or complex, can be quickly and economically produced the Yoder way from a wide variety of flat-rolled coated or uncoated stock . . . in thickness up to ¾ inch . . . in speeds up to 50,000 feet per day.

Yoder engineers flexibility and precision into metal forming operations. For example: many basic shape modifications, such as coiling, welding, notching, ring-forming, perforating, and cutting to length can be simultaneously accomplished with little or no additional labor cost.

Yoder also makes a complete line of Rotary Slitters and Pipe and Tube Mills. Profit from Yoder's years of engineering and service experience, contact your local Yoder representative or send for the Yoder Roll-Forming Manual.



THE YODER COMPANY
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This fully-illustrated 88-page book clearly discusses every important aspect of Yoder Roll-Forming Equipment and methods . . . it's yours for the asking!

ENGINEERING **YODER** MANUFACTURING

COLD ROLL FORMING MACHINES
PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

Circle 697 on Page 19

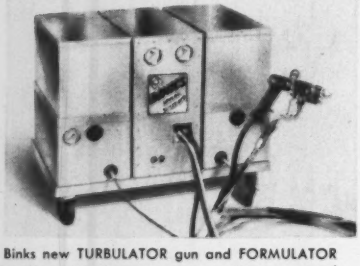
sprays or flows the new MULTIPLE COMPONENT MATERIALS for finishing, coating or build-up

Binks new TURBULATOR spray gun and FORMULATOR are a major break-through in the spray application of a whole array of catalyzed epoxy coatings and casting resins . . . polyester gelcoats and reinforcing resins . . . foam-in-place materials and other synthetic coatings requiring a catalyst.

Binks TURBULATOR gun may also be used for the flow-on application of plural component materials.

The FORMULATOR provides a self-contained reservoir for resin and catalyst materials. It accurately meters and proportions the flow and volume of each material to the TURBULATOR spray gun.

Operation is simple . . . only basic instruction is necessary.



Binks new TURBULATOR gun and FORMULATOR equipment package opens up vast new areas of finishing, coating and build-up material technology . . . for the first time really places this technology at your disposal . . . opens up exciting new production possibilities never before practical.

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Learn the details of this remarkable advance in spray or flow applying new "miracle" materials.

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Circle 698 on Page 19

as punch presses. In operation, the switch shuts off the power at the end of each cycle and automatically starts the cycle unless interrupted. The switch is connected to the solenoid which actuates the cycle. The cycling time can be adjusted within limits. Illustrated unit is rated for 3 amp at 115 v ac. **Superior Carbon Products Inc.**, 9115 George Ave., Cleveland 5, Ohio.

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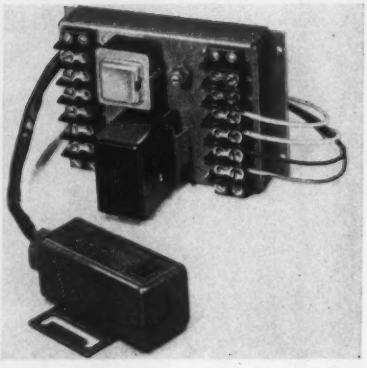

Proximity Switch

Device consists of a sensor and a separate transistor amplifier with plug-in relay. It is designed for use under unfavorable environments such as those created by oil, grit, extreme vibration, dirt, or sludge. The sensor detects magnetic material without physical contact and transmits an electrical signal to the remotely located amplifier. The amplifier operates a double-pole, double-throw relay which is wired to the circuit as a limit switch would be used. The sensor and amplifier can be located up to 150 feet apart, without the use of shielded wire. The switch can sense products ranging from automotive frames to bottle caps. It can also sense products with highly polished surfaces without touching them, eliminating the possibility of scratching. Unit has an adjustable sensitivity range of $\frac{1}{8}$ to $\frac{1}{2}$ inch. A centralized sensing pole increases the latitude of directional approach of the workpiece to the sensing face. It can be energized from 115 v, 60 cycle power. **Micro Switch, Div., Minneapolis-Honeywell Regulator Co.**, Freeport, Ill.

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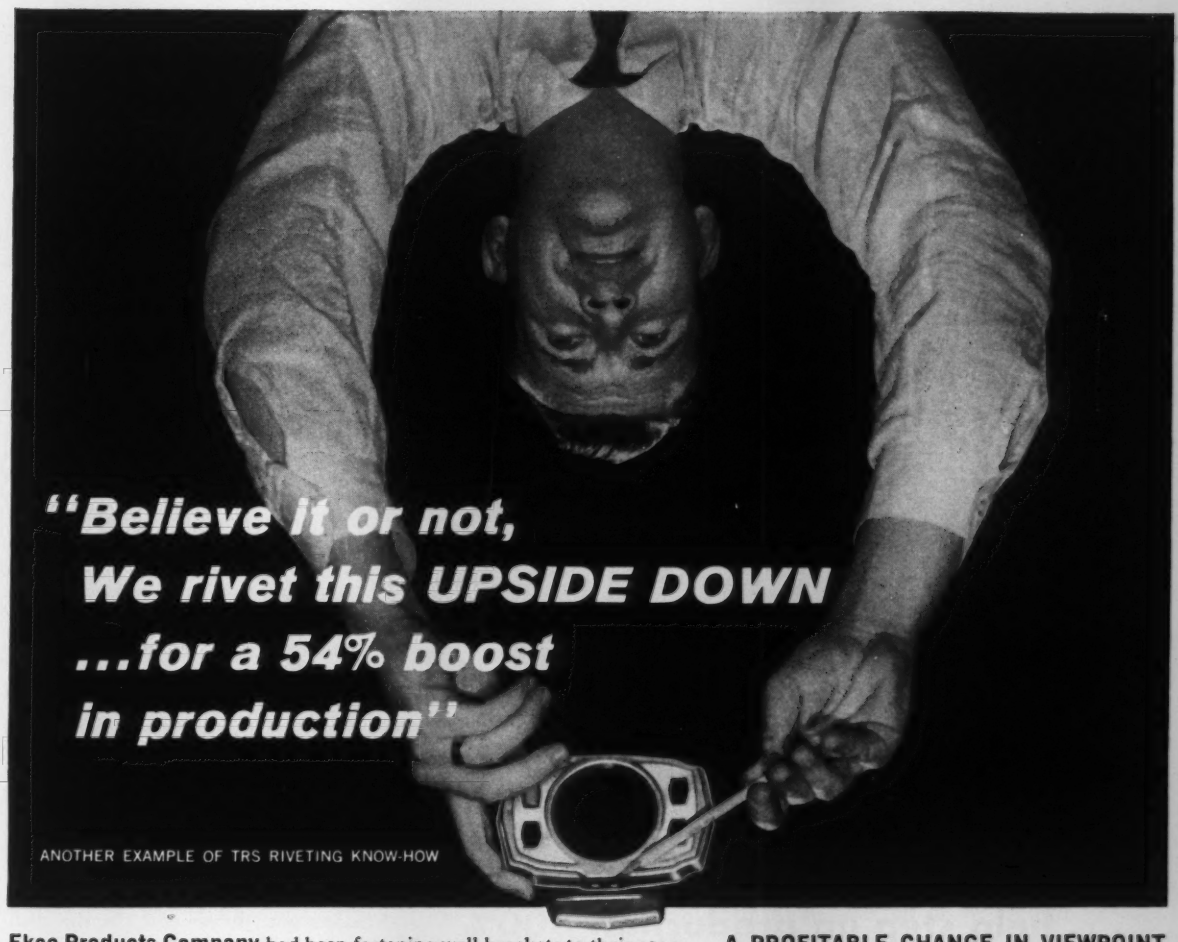


Ekco Products Company had been fastening wall brackets to their soap dishes and glass holders with solid aluminum rivets . . . hand-assembling the components and placing the assembly in a die which required two press strokes to fasten the parts. Production volume had reached a ceiling, and cost reduction was becoming imperative.

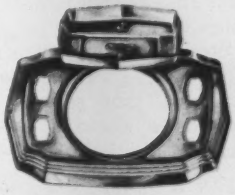
Automatic machine riveting, with semi-tubular rivets, would offer substantial savings, but obstructing flanges on the product itself seemed to rule it out . . . until the TRS man suggested a new viewpoint. Working with Ekco engineers, he proposed feeding the rivets upside down and inverting the assembly for the fastening operation, providing unobstructed travel for the rivet-setting driver. The rivets were kept with the heads visible, as required for good appearance.

Result: no hand assembly, daily output up 54%.

Let the TRS man look over your assemblies. You'll find that he has the viewpoint of a manufacturing engineer, and a knack for making fastening simpler, faster, better.

Of course he will recommend TRS rivets. But he will give you sensible reasons why they are more reliable in quality and uniformity. Superior quality control is one big result of a five-year modernization of this pioneer company — modernization of people, policies, production and service facilities. *You'll like to do business with the new TRS . . . we'll make sure of it.*

A PROFITABLE CHANGE IN VIEWPOINT



In the Ekco-Autoyre glass holder (shown) and soap dish, the rivet clinch must not be visible, but normal setting with the rivet heads on the visible surface was impossible because flanges on the product obstructed motion of the setting driver. To solve the problem, a semi-tubular rivet was designed with a flat head, to be fed and set in an inverted position with a TRS Model 103L machine. The end of the driver was shaped to form the clinch, and the machine was fitted with an air-operated pusher to eject the finished product.

Don't Buy Riveting Machines until you learn how the TRS **PAR** *process revolutionizes riveting*

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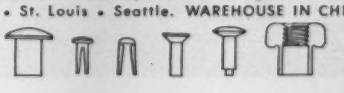
If it's a Tubular Rivet TRS makes it . . . and Better



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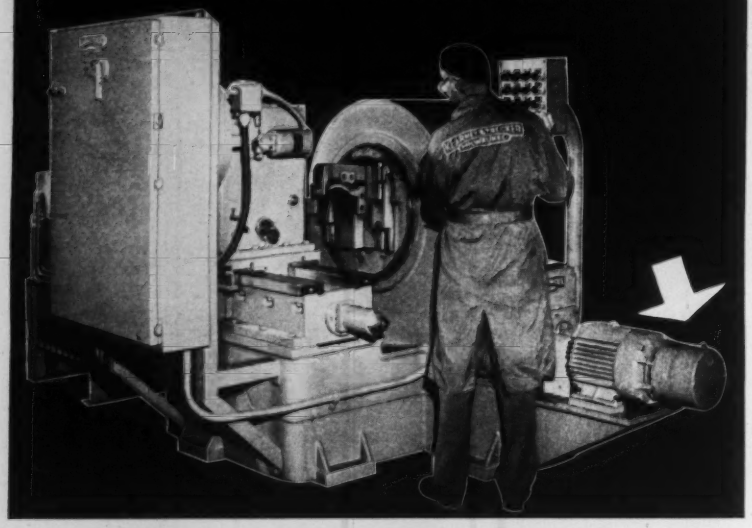

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This special "K & T" two-spindle, precision, production machine tool for the electric power industry mills both inside and outside radii of curved, alloy steel turbine blades in a single pass — at three times former conventionally tooled feed rates. A versatile 360° drum fixture handles 81 different blade sizes *without overtravel on rapid stroke for extremely short cycle time* . . . a function of Stearns Brakes on machinery for all industries. "K & T" engineers specified Stearns for this tough, rapid-cycle application due to previous experience . . . the efficiency, longer life, exclusive "Visi-Wear-Indicator," and ease of installation and maintenance — the only brakes where a screwdriver is a complete maintenance tool kit.

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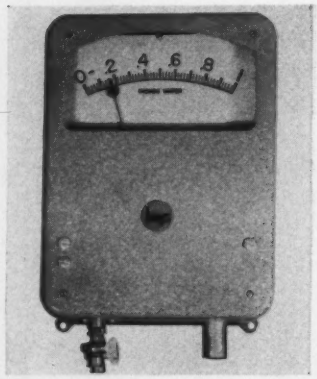

Indicating Transmitter

Instrument can provide pressure indication at the point of measurement or within 300 feet. Model 231 can simultaneously transmit the pressure measurement electrically to a remotely located recorder or indicator. It is used in measurement of pressure or differential pressure of air or noncorrosive gases, in ranges from 0-0.2 to 0-120 inches water and for static pressure up to 65 psig.

In operation, variations of pressure or pressure differential produce movement of the sensing element which simultaneously moves the indicating pointer and the core of a differential transformer. This core movement is matched by a circuit balancing movement of the differential transformer core in the remotely-located recorder or indicator. Hays Corp., Michigan City, Ind.

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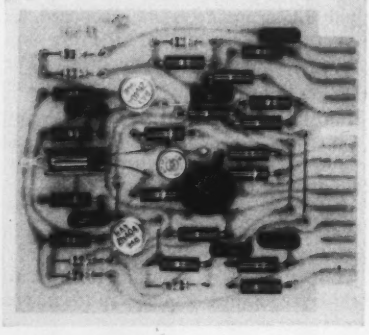
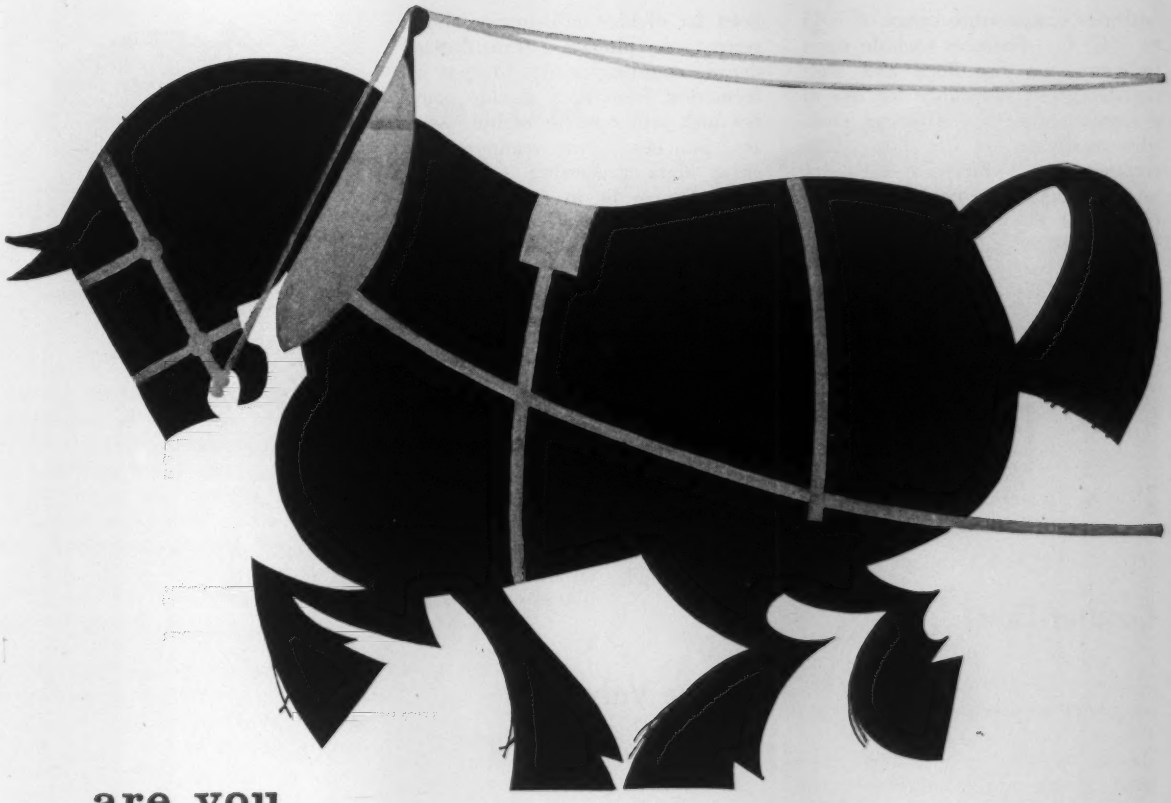
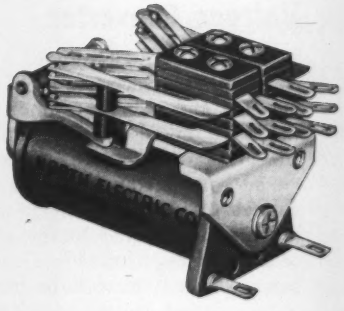


Digital Module

Line of transistorized digital modules is applicable for digital systems, timing and control, data processing, test equipment, instrumentation, and digital servos. Operation is



are you using North Electric's Workhorse "E" relay?



Expanded production facilities and increased efficiency in manufacturing methods have enabled North Electric to step up production of "E" relays to provide prompt delivery (at a new low cost, too) to an ever-growing list of steady customers.

If you need a relay that incorporates the inherent proven dependability of a telephone-type relay with minimal spatial requirements, this "little workhorse" from North can be your answer!

GENERAL CHARACTERISTICS:

Light Weight (2½ ozs.)
Compact (Length 2¼"; Width 1⅛"; Height 1¾" max. with 10 springs in either pile-up)
Long Life (over 100 million operations)

SPECIFICATIONS:

Coil Voltages: Up to 250V DC
Contacts: Independent action twin contact springs
Contact Materials: Palladium, Gold, Platinum
Forms: A to C
Speed: 3 ms. minimum
Residual: Lock Screw (adjustable)—Fixed (nylon flap type)
Time Delay: Available for both operate and release
Coil: Single or Double wound
Mountings: 2 #6-32 Screws on ¾" spacing
Accessories: Dust Cover and Hold Down Bracket

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

623 S. Market St. *Galion, Ohio*

Circle 701 on Page 19

within a temperature range of −45 to +65 C. Features include neon indicators on flip flops and shift registers, and allowance for use of a remote indicator. Types of modules available are flip flops, shift registers, multi-vibrators, one-shots, and dc logic. **Control Equipment Corp.**, 19 Kearney Rd., Needham Heights 94, Mass.

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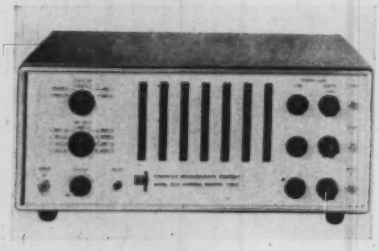


Counter-Timer

Instrument is a solid-state dc to 10 megacycle counting, timing, and frequency measuring unit. It consists of three input channels, a special decade count-down time base, timer which eliminates the need for divider adjustment, and a series of plug-in, transistorized decade counting units. Output information from each decade counter unit will operate digital printers, punches, inline readouts, and other data processing equipment. Readout can be in either the vertical numeral panels or in the inline Nixie version. Unit is available in three styles—Model 727A (shown) is a transistor counter-timer; Model 707A is a transistor frequency-period meter; and Model 757A is a transistor time interval meter. Measurement ranges are dc to 10 mc for frequency; 0.1 mu sec to 10^7 second for time interval; 0.1 mu sec for period. Sensitivity is 0.25 v rms; input impedance is 25 k ohms per volt. **Computer-Measurements Co.**, 12970 Bradley Ave., Sylmar, Calif.

Circle 440 on Page 19

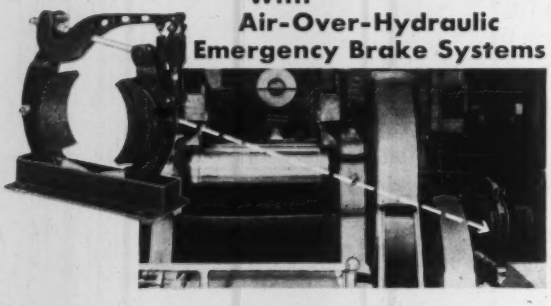
In-Line Valve

Rated for 300 psi maximum pressure at 180 F, ½-inch in-line valve has a flow coefficient of 7.5. It is

ported on both sides of the operating piston and can be assembled for spring-to-open or spring-to-close operation. The valve can also be operated without the spring as a double acting piston for hydraulic actuation. Unit is constructed with a bronze sleeve and bridge, a stainless steel plug, and Neoprene O-rings. It can be furnished with Teflon or other soft seats and can be engineered to specific requirements for control signal actuation. **George W. Dahl Co. Inc.**, 86 Tupelo St., Bristol, R. I.

Circle 441 on Page 19

STOP "INRUNNING ROLLS" SAFELY
With
Air-Over-Hydraulic
Emergency Brake Systems



Wagner A/H Emergency Brake Systems protect the operator (as required by safety codes) against the extreme hazards involved in operating machinery with inrunning rolls. An industrial-type brake is applied by an air-operated hydraulic power cluster to stop rolls quickly, smoothly, and with minimum strain on the drive. Systems incorporate safety devices to meet other emergencies, such as loss of air pressure or failure of power supply.

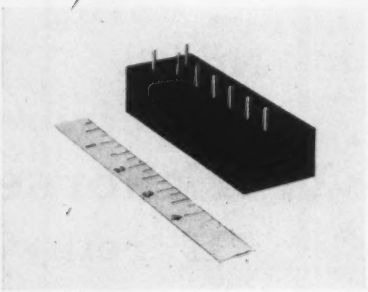
Brake assemblies are ruggedly constructed, are easy to install . . . require no special motor starters or control, no direct current. Maintenance is minimized . . . there is practically no lining wear, no heavy solenoid coils to burn out.

Apply these systems to your rubber or plastic mills, refiners, washers, crackers. Available with 6, 8, 10, 14, or 18 inch diameter brakes. Your nearby Wagner Sales Engineer has the complete story. Call him, soon.

W160-3

Wagner Electric Corporation
6430 PLYMOUTH AVE., ST. LOUIS 33, MO., U.S.A.

Circle 702 on Page 19



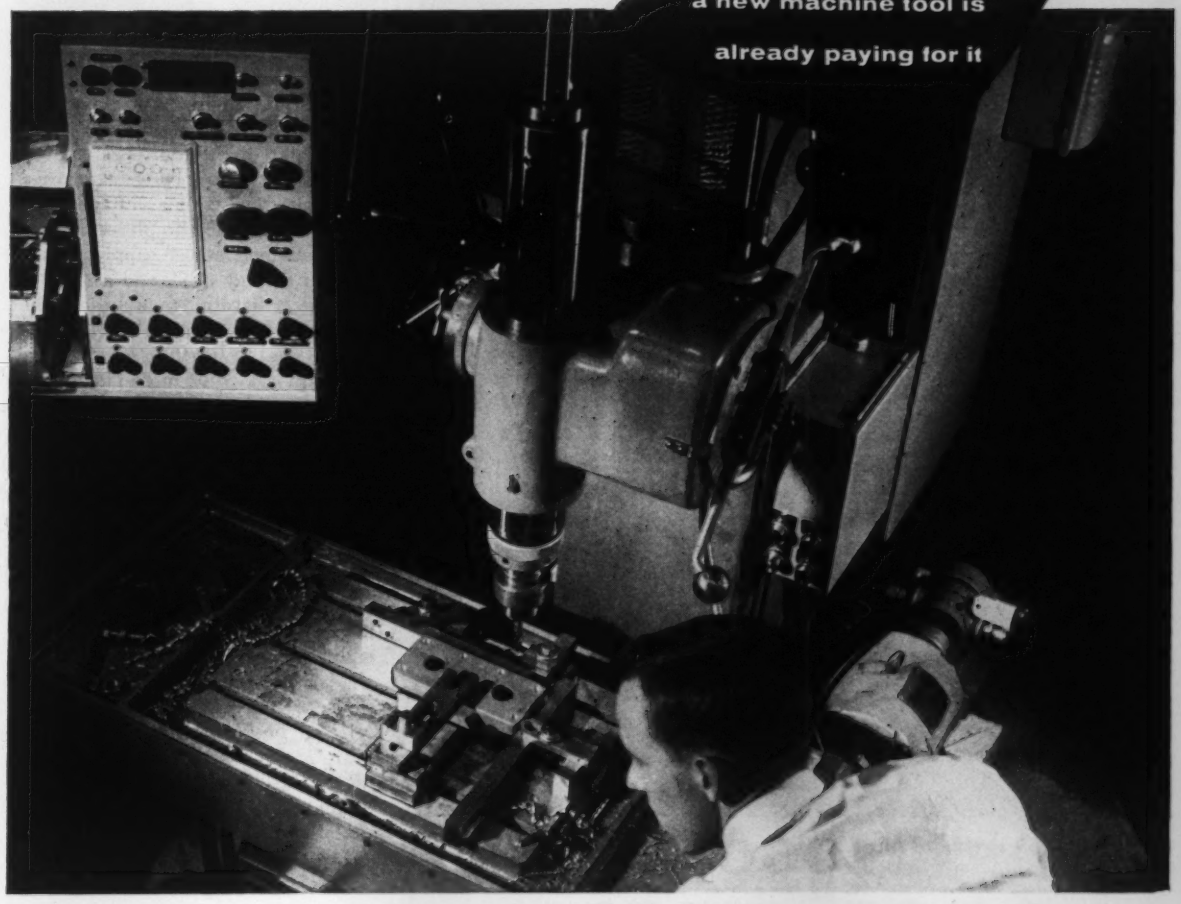
Voltage Converter

Solid-state digital-to-ac voltage converter has accuracies of 0.025 per cent and switching times of less than 100 microseconds. Inputs to the unit are a digital number and an ac voltage; the output is an ac voltage of identical frequency with an amplitude equal to the product of the inputs. Individual modules for each input bit can be mounted on an etched board. A 10-bit device requires less than 20 cu in., will operate from −54 to +95 C. **Packard Bell Computer Corp.**, 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 442 on Page 19

JONES & LAMSON "AUTOMATION"

the man who needs a new machine tool is already paying for it



Numerical control positioning eliminates jigs – saves time

The J&L Numerically Controlled Positioning Table quickly and accurately positions work pieces to an accuracy of ±.001″ — without jigs. And it can do it economically with any lot size down to a single piece.

For instance: in one installation, where precision parts previously had been machined on a conventional spacing table, J&L's new equipment achieved cycle time savings of six minutes per piece and set-up savings of over 116 minutes per set-up, or a total savings of 6.95 hours on a lot of 50 pieces.

In another plant, the cost of building $4,000 worth of jigs was eliminated during the first six weeks of operation. And in still another operation, the positioning table not only reduced set-up and cycle time, but also eliminated the storing, handling and maintenance of $29,000 worth of jigs.

You can get in on this kind of savings too. Write to Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Fay Automatic Lathes • Milling & Centering Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 703 on Page 19

1960
TOOL SHOW
and CONFERENCE

DETROIT ARTILLERY ARMORY
APRIL 21ST THRU 28TH

The nation's foremost forum for the advancement of scientific knowledge in the field of tool engineering

for rapid registration forms write:
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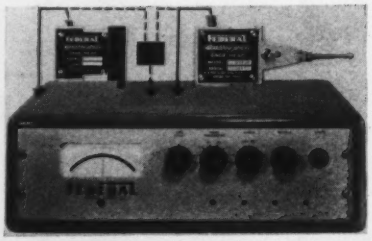
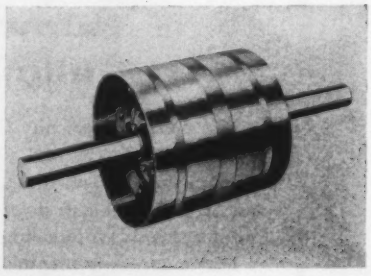


Electronic Gage

Electronic gaging and classifying unit has eight ranges from ±0.020 to ±0.0001-inch, four size control limits, and five sorting categories. The unit consists of a voltage regulated vacuum tube amplifier, a four-limit classifier, power supply, meter, number display tube, and associated circuitry. Several gage head combinations can be used with Model 230 M-27. With the addition of an adaptor, two or more gage heads can be switched to the amplifier individually or used in combination. The gage heads can be arranged so their outputs are either additive or subtractive. Two styles of gaging heads can be used. In the illustration, the gage head at the left has a pantograph-mounted sensitive contact; the one at the right has a lever type contact. Any one of the eight ranges can be selected with the panel-mounted switch. A 5-inch precision meter displays the selected range on one of three separate scales which provide a choice of 10, 20, or 50 graduations on either side of zero. **Federal Products Corp.**, Providence 1, R. I.

Circle 443 on Page 19

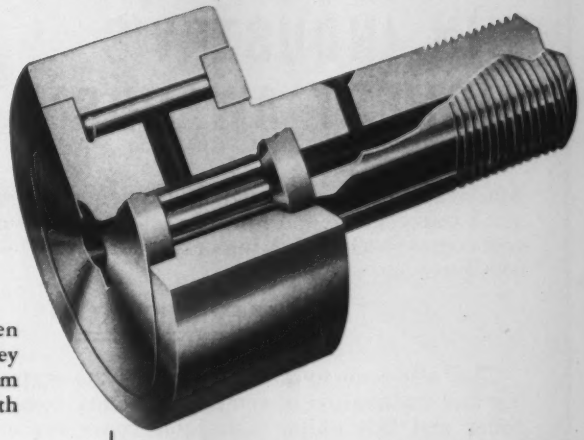


Magnet Pulley

Line of permanent magnet pulleys, in diameters from 12 to 48 inches, is suitable for heavy-duty tramp iron removal and cobbing applications. Pulley is constructed of

AUTOMATION TIPS
by McGill

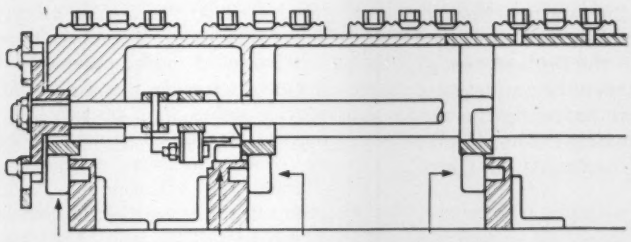
CAMROL® bearings offer these advantages over improvised cam follower, track, guide and support roller units



- *lower cost*
- *simplicity of design*
- *precision accuracy*
- *easy installation*
- *small space requirements*
- *high load capacity*

It doesn't pay to "build up" special roller followers when CAMROL bearings offer better performance for less money in an integral standard stock unit. Roller diameters from ½" to 4" are available from stock in either the CF (with stud) or CYR (for shaft mounting).

Pre-lubricated and sealed for protected performance SCF Series CAMROL bearings provide better lubrication retention and sealing against contamination.



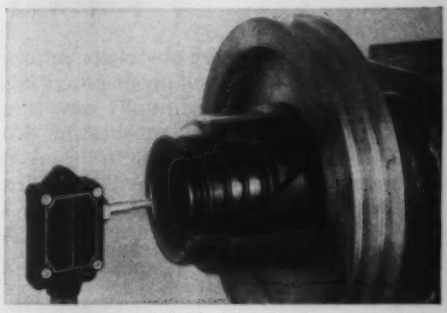
CAMROL® bearings accurately support and guide fixtures in automatic NATIONAL ELECTRIC WELDING MACHINES

Work-holding tables arranged as a continuous conveyor carry condenser assemblies beneath welding rollers in multiple station resistance-welding machines manufactured by National Electric Welding Company for a manufacturer of household refrigerators.

CAMROL precision accuracy assures proper positioning of the work pieces and trouble-free operation of the machine.

National Electric Welding Machines Company selected these bearings to assure accurate alignment and low maintenance. The bearings are pre-lubricated and sealed for life. An additional benefit was gained because of the ease of assembly. In each machine 154 CAMROL bearings are used as support bearings and 56 CAMROL bearings guide the fixtures.

CAMROL® bearings add precision protection to overload cut-outs on ANCHOR CONVEYORS



Anchor Steel and Conveyor Company relies on MCGILL CAMROL bearings for positive operation of Anchor overload cut-outs. When dangerous overload occurs, the spring-loaded sleeve is actuated by forcing the CF bearings up the inclined cam faces. Shock load capacity and precision anti-friction dependability help protect motors and machinery from damage due to overload. CAMROL bearings last 4 to 5 times longer than bearings previously used, and have a record of better performance, more load capacity and less maintenance.

For complete data on the full line of McGILL PRECISION NEEDLE ROLLER BEARINGS, SEND FOR CATALOG NO. 52-A.

engineered electrical products

McGILL®

precision needle roller bearings

MULTIROL-GUIDEROL-CAMROL-CAGEROL

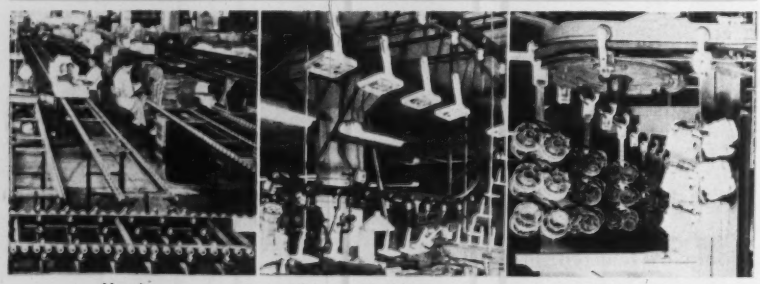
McGILL MANUFACTURING COMPANY, INC., Bearing Div., 401 N. Lafayette St., Valparaiso, Indiana

BUSCHMAN CONVEYORS WIN INDUSTRY'S HIGHEST AWARDS

American business is rough and tough and demanding, yet quick to recognize and reward real merit. The best and biggest companies buy Buschman standardized wheel, roller and belt conveyors out of stock.

They also come to this Company for the engineering, building and installation of complete systems, comprising wheel, roller and belt units, table-cable conveyors and overhead trolleys. Often they ask the near-impossible in conveyor accomplishment . . . *and from Buschman they get it!*

These customers obviously appreciate the engineering excellence, quality and profit potentials so evident in Buschman products. They continually reward us with the highest recognition that industry can bestow. *Namely, orders and repeat orders.* We thank them for their original patronage; even more for their extremely significant encores! The E. W. Buschman Company, 4551 Clifton Ave., Cincinnati 32, Ohio.



Macy's *Minneapolis–Honeywell* *Ford Motor*

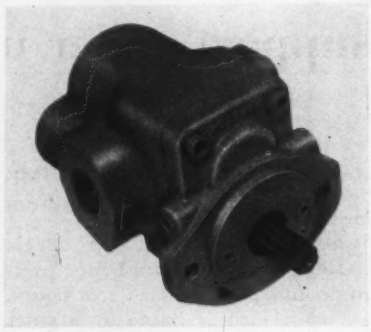
Buschman
CONVEYORS

Complete Conveyor Systems for all Industries—Engineered, Manufactured, Installed
Representatives in Principal Cities

360

ferrite ceramic magnet material, does not require coils, rectifiers, switches, or other electrical gear. Other pulleys in the line are available in 30, 36, 42, and 48 inches in diameter. **Stearns Magnetic Products**, 635 S. 28th St., Milwaukee, Wis.

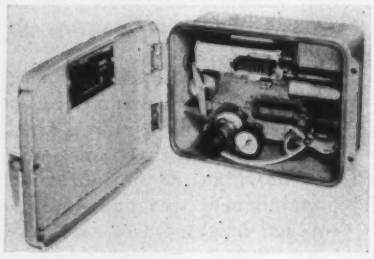
Circle 444 on Page 19



Hydraulic Gear Pump

Device, designated Model PM-110, can be used as a motor without any modification or adjustment. It is rated at 2000 rpm, 1500 psi at 20 gpm. The pump is completely pressure-balanced with automatic adjustment of wear plates, is said to provide better than 90 per cent efficiency. It can be driven clockwise or counterclockwise without any change or adjustment. Another pump in the series (Model PM-106) is rated at 2000 rpm, 1500 psi at 13 gpm. **Be-Ge Mfg. Co.**, P. O. Box 67, Gilroy, Calif.

Circle 445 on Page 19

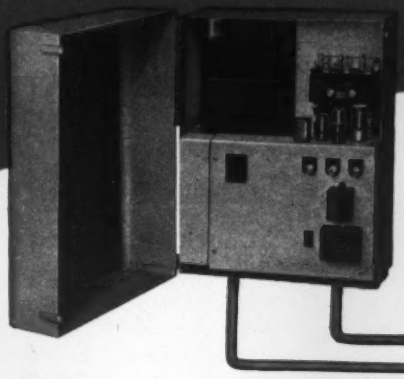


Pneumatic Integrator

Suitable for weighing materal being transported on a conveyor belt, unit multiplies belt travel with belt loading to produce direct readout of the true weight being conveyed

DYNAMATIC®

Drive Package Provides Infinitely Adjustable Speeds from AC Power Source



CONTROL PANEL

CONTROL STATION

The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

Speeds are infinitely adjustable from 0 RPM to full output speed, and accurate speed regulation may be obtained from 100 RPM to full output speed.

Ajusto-Spede® Drives, available in ratings of 1/4 horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

DYNAMATIC®
AJUSTO-SPEDE DRIVE

Send for Illustrated Literature Describing Dynamatic Adjustable Speed Drives

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 707 on Page 19

over the weighing section. The integrator is composed of two major components—a precise force-balance positioner and a disc-and-wheel integrator mechanism. The 7-digit totalizer is direct reading in pounds, tons, or long tons and does not need multipliers other than ciphers.

In operation, totalization of material passing over the weigh scale is accomplished by pneumatically positioning an integrating wheel in proportion to the belt load and driving this wheel with a rotating disc whose speed is proportional to belt travel. The disc of the integrator assembly is driven by an enclosed flexible shaft rotated by a roll in contact with the moving belt. A pneumatic load cell on the weigh scale transmits to the positioner in the integrator, a signal pressure directly proportional to the weight of the material on the weighing section of the belt. The integrating wheel is geared to a cyclometer counter which totalizes the true weight passing over the weighing section. **B-I-F Industries Inc.**, 345 Harris Ave., Providence, R. I.

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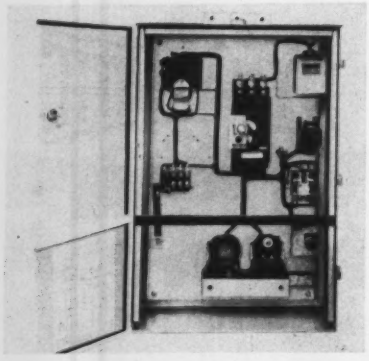
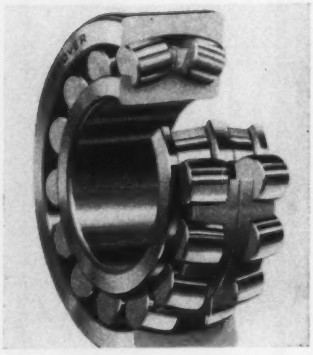


Well Pumping Control Unit

Unit is designed to automatically control and protect squirrel-cage motors that drive oil well pumps. The three-phase, 60-cycle, 220/440 v ac control unit is used on motors rated from 3 to 100 hp, NEMA sizes 0, 1, 2, 3, and 4. Feature of the controller is a three-pole TC relay which gives positive protection against locked rotor, single-phase starting and running, and normal overload. The relay is insensitive to changes in ambient temperatures encountered in oil fields. The controller has automatic time sequence restarting and 15-minute interval programming. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa.

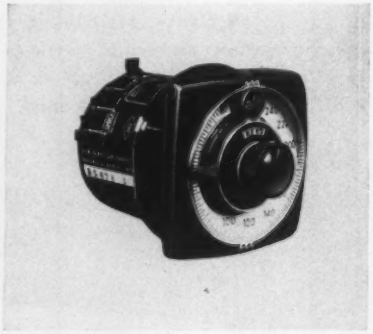
Circle 447 on Page 19



Spherical Bearing

Spherical roller bearing is designed with a double row of large-size rollers which can accommodate excessively heavy radial and shock loads. High contact angle provides for substantial thrust capacity in either direction. A single spherical outer raceway is used to permit the bearing to compensate automatically for shaft misalignment in any direction, either initially or dynamically under load. Roller guidance is provided by a heavy center guide flange between the two inner raceways, asymmetric roller design and heavy machined-bronze, land-riding retainers. **Bearing Div., Hoover Ball & Bearing Co.**, 5400 S. State Rd., Ann Arbor, Mich.

Circle 448 on Page 19



Shaft-Driven Counter

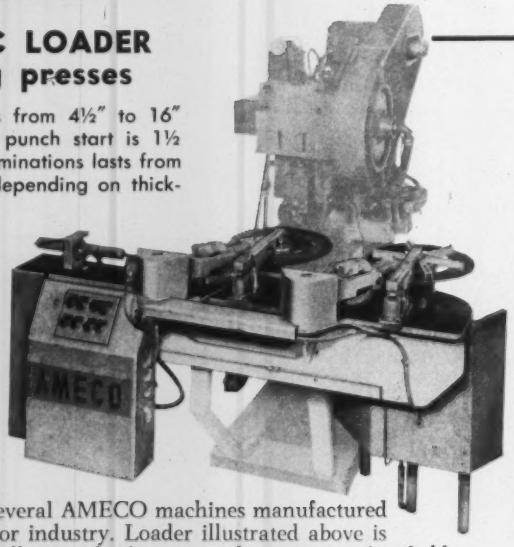
Miniature device counts shaft revolutions up to 1000 rpm and re-

AMECO

BUILDERS OF QUALITY MACHINES FOR AUTOMATION

AUTOMATIC LOADER for notching presses

Handles laminations from 4½" to 16" dia. Punch stop to punch start is 1½ seconds. Stack of laminations lasts from 45 to 90 minutes, depending on thickness.



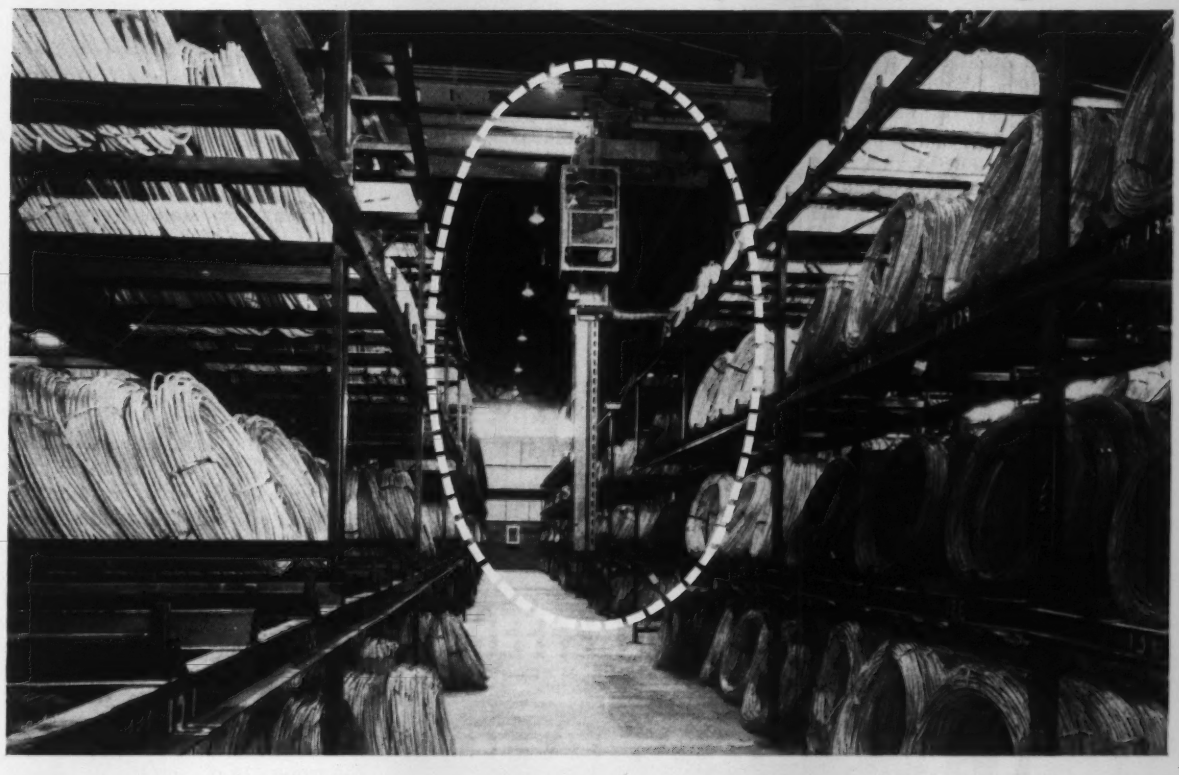
This is one of the several AMECO machines manufactured for the electric motor industry. Loader illustrated above is type used by the following leading manufacturers in this field: Louis Allis, Elliott, Fairbanks-Morse, General Electric, ILG Ventilating, Imperial Electric, Master, Robbins & Myers, Tamper and Westinghouse.

AUTOMATION MACHINES & EQUIPMENT CO., INC.

3130 W. MILL RD., MILWAUKEE 4, WIS.

Circle 708 on Page 19

How a TRAK-RAK Crane Can Save You Money BEFORE IT'S INSTALLED....



And Pay For Itself in Time and Labor Savings After It Goes to Work!

Considering an addition to your present storage facilities—or planning construction of a new warehouse building? A TRAK-RAK Crane can save you money by permitting a sharp reduction in the overall size of the addition or building . . . and still enable you to store the same volume or tonnage.

Hundreds of installations in warehouses and plants of every type are proof of the speed, efficiency, and economy of the TRAK-RAK System. A recent installation at Chandler Products Corporation, Cleveland, is a case in point.

> In an area of 20,000 sq. ft., 7500 coils (2,500,000 lbs.) are stored four high—using the floor and 3-tiered racks. The TRAK-RAK Crane handles the entire stock, from unloading coils at the rate of 1000 lbs. per minute from trucks, to moving them in and out of storage. Manpower savings of 70% . . . increased handling speed and safety . . . optimum rotation of stock . . . and a considerable reduction in warehousing costs are reported by the Company.

A TRAK-RAK Crane can be installed in your present warehouse area, enabling you to increase storage capacity, speed handling, and reduce costs. *Why not write for details now?*

TRAK-RAK Crane at truck unloading area. Unit unloads 1000 lbs. of coil stock per minute.

CTC CHICAGO TRAMRAIL CORPORATION | 1306 SOUTH KOSTNER AVENUE CHICAGO 23, ILLINOIS

quires only 1¼ oz-in. torque to provide automatic control for measurement of textiles, tapes, hose, and wire lengths; for product counting; for fluid metering; for material and conveyer feeding; and for spring, armature, and mill roll winding. With the clutch energized by external momentary or sustained switch contact, the counter will indicate revolutions of a machine drive shaft until a predetermined dial setting is reached, tripping the heavy duty spdt control contacts. A totally-enclosed gear train reduces the number of input shaft revolutions to a single turn representing full scale of the dial. Once adjusted to range, the dial setting remains fixed for repeated operation. Repeatability is ±0.0025 of dial range. Counter is available for ac or dc operation, with eleven dial ranges from 0-12 to 240,000 revolutions, and in numerous circuit arrangements. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

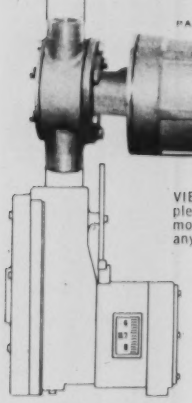
Circle 449 on Page 19

BE SURE YOUR GAGE READS 29 TRUE 30

1800 RPMs ELIMINATE FRICTION EFFECTS

S&J VIBRAMATIC ELECTRIC TAPE VIBRATOR

MODEL 0701



VIBRAMATIC, complete with electric motor, adapts to any tape-type gage.

Gaging tape is "friction-free" for accuracy and repeatability to better than 1/16"—when applied to S&J Gages. For an instant before each reading, VIBRAMATIC puts tape into frictionless "fluid" state. ADAPTS EASILY TO ANY TAPE-TYPE GAGE; automatically energized for remote reading, manually controlled for tankside reading. Separate from gage itself: does *not* paralyze gage if power fails; guided float will *not* sink! S&J engineered for long-life reliability. Motor in explosion-proof aluminum housing. *Details sent immediately upon request.*

• Tape in "fluid state" to eliminate friction • Assures accuracy and repeatability to better than 1/16" • Repeatability 100% • Power needed only at reading time • For remote or tankside gages

SHAND AND JURS | A GENERAL PRECISION COMPANY

SHAND AND JURS CO.
2600 EIGHTH STREET
BERKELEY, CALIFORNIA
A subsidiary of General Precision Equipment Corp.

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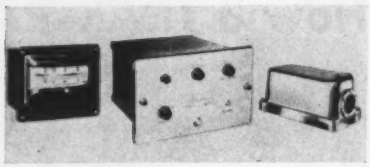
REPRESENTATIVES: Seattle • Denver • Montreal • Toronto • Vancouver • Calgary • Mexico, D.F. Caracas • England • and other countries

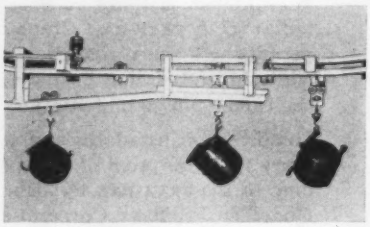
Circle 710 on Page 19



Radiation Thermometer

Instrument automatically measures and controls the temperature of moving or stationary objects without physical contact. It is applicable in the metals, plastics, rubber, glass, paper, and chemical industries. Model TD-3 operates on the principle that an object emits thermal, or infrared radiation as a function of its temperature. This radiation from an object is received by the unit, translated into a signal voltage and amplified to a level sufficient to drive an indicator calibrated directly in temperature. The infrared sensing element is hermetically sealed within an optical head that can be mounted onto any surface at a given working distance and aimed at the object to be measured. Lowest temperature range for this unit, designated Thermodot, is 400 F; highest standard range is 2000 F. **Radiation Electronics Co.**, 5600 W. Jarvis Ave., Chicago 48, Ill.

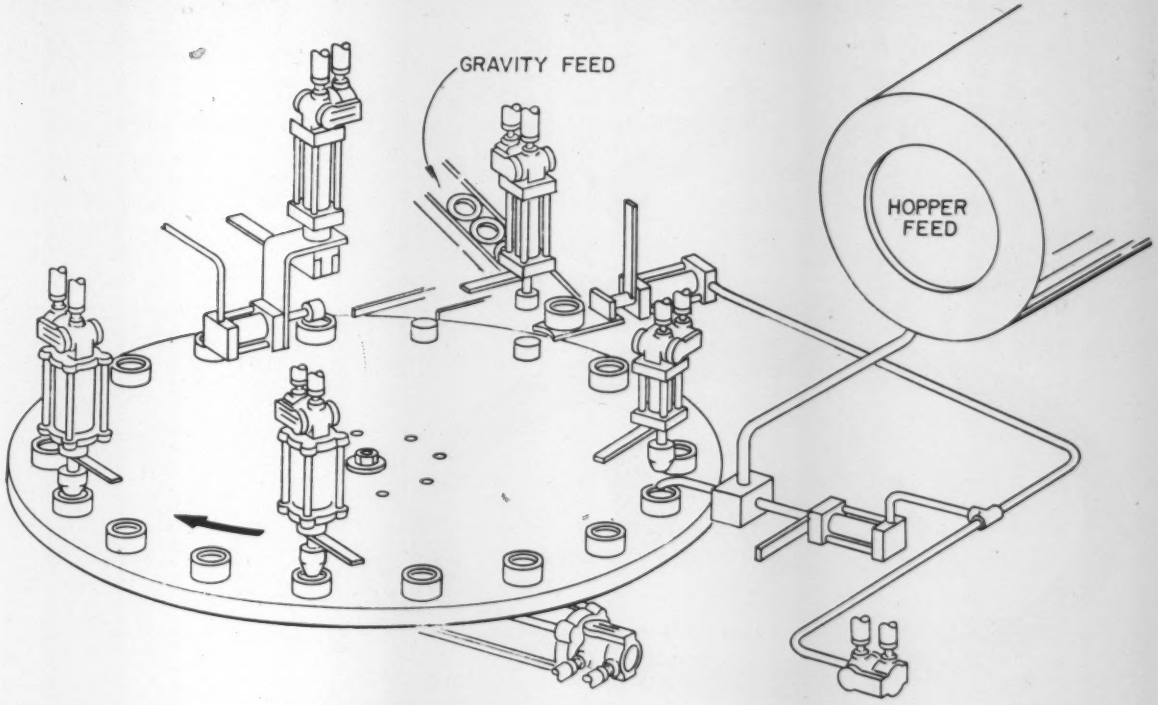
Circle 450 on Page 19



Conveyor Trolley

Piggy-back type conveyor trolley is designed to pick-up and carry other trolleys which carry the load. The loaded trolleys can be conveyed from one operation to another, transferred from one conveyor system to a second one, deposited on a side track for storage, and then picked up again when needed. The two trolleys are automatically controlled, can be separated at any desired point; the trolley under power continuing along the main conveyor track and

THIS BELLOWS "SPOT-A-MATION IDEA" SAVED $82,754.00

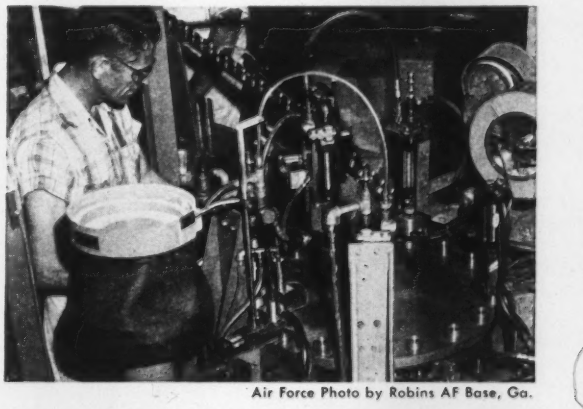


Engineers at the Naval Ordnance Plant, Macon, Georgia, were given the assignment to "effect major production economies" in the assembling of explosive components for ordnance use. The operations were being performed manually by 33 people. The engineers designed and built two automatic assembly machines, each using a Bellows Rotary Index Table and five explosion-proof Bellows Air Motors. The savings on direct labor costs alone on one contract amounted to .0109 man-hours per assembled part for a total dollar savings of $82,754.00.

This same basic idea can be readily adapted to handle an almost unlimited range of small parts assembly procedure: staking, crimping, screw or stud placement, welding partial or complete small assemblies, etc.

It is typical of the many ways ingenious engineers "spot-automate" costly and troublesome production centers with Bellows "Controlled-Air-Power" Devices.

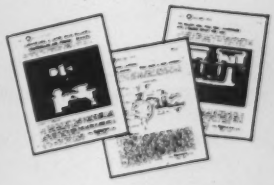
Chances are that many such opportunities exist in your plant. Why not investigate today?



Air Force Photo by Robins AF Base, Ga.

The savings of $82,754.00 made through these automatic assembly units are based on direct labor costs and are exclusive of any possible savings from reduced overhead. In addition, 1000 sq. ft. of floor space was released for other operations.

THIS "SPOT-A-MATION IDEA" FILE IS YOURS ON REQUEST



Contains installation data, wiring diagrams and equipment lists for the assembly idea sketched above, as well as a score of other "Spot-a-mation" ideas you can use. Write Dept. AU-360 The Bellows Co., Akron 9, Ohio.

1492-B

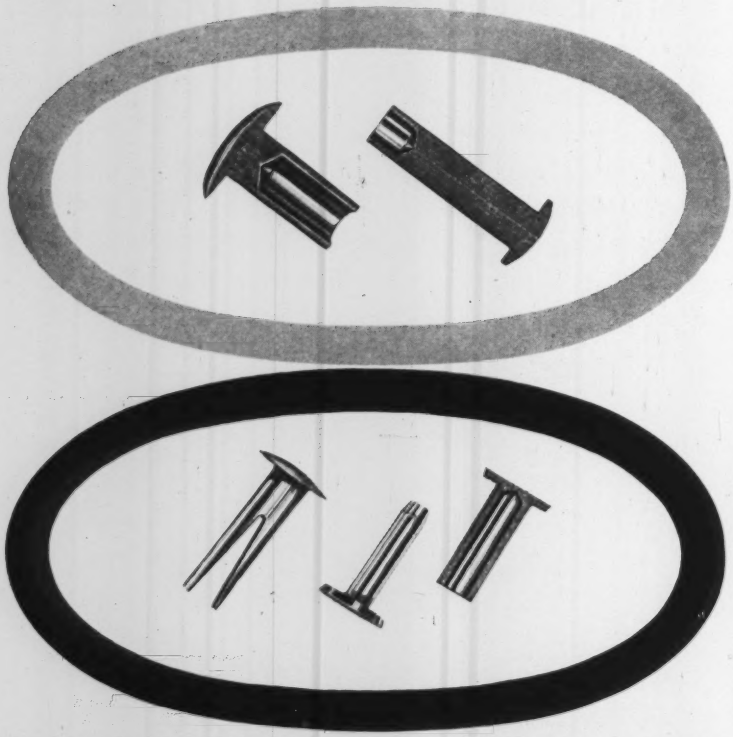
The Bellows Co.

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

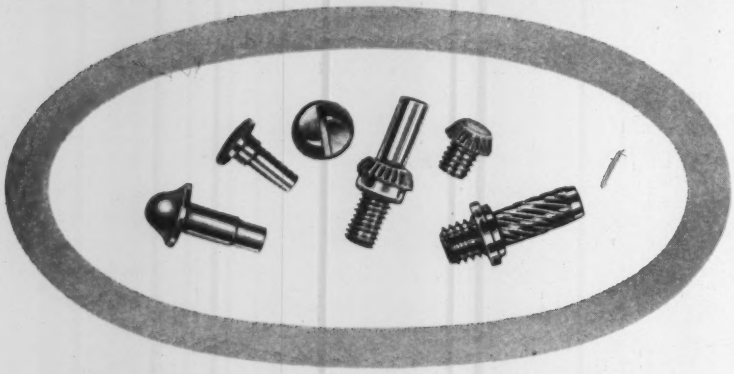
AKRON 9, OHIO

OTHER INDUSTRIAL DIVISIONS OF IBEC: Sinclair-Collins Valve Co., Valvair, Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio

Circle 711 on Page 19



COST PREVENTION...NOT COST REDUCTION...IS THE EFFICIENT WAY TO LOW-COST ASSEMBLY



The "in-place" cost of a fastener is what really counts to cost-conscious production men. By deciding on inexpensive Milford tubular rivets as a fastening method and installing them with Milford automatic rivet-setting machines, design and production engineers are eliminating costs at the initial production stage rather than trying to reduce costs later at the assembly line.

You can find out more about Milford's cost-cutting ideas by asking your Milford Representative to show you Milford's new MANUAL OF MODERN RIVETING PRACTICE. It's crammed with valuable cost-cutting tips and technical data that can be quickly translated into dollars on your production line.

THE MILFORD RIVET

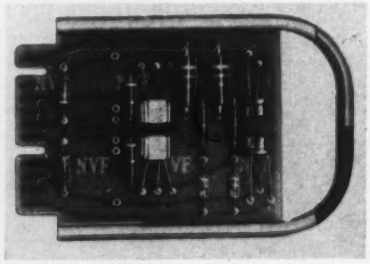
MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • NORWALK, CALIFORNIA
ELYRIA, OHIO • AURORA, ILLINOIS • HATBORO, PA

Circle 712 on Page 19

the load carrying trolley moving along another track which starts at the transfer point. The loaded trolley is then directed onto a side track area, a work area, or to a point where it is automatically picked up either by a second conveyor system or retrieved again by the same conveyor. **Econ-O-Veyor Corp.**, Dept. O, 224 Glen Cove Ave., Glen Cove, N. Y.

Circle 451 on Page 19



Solenoid Driver

Device contains two independent solenoid driver circuits. Each circuit amplifies the output of a transistorized digital module to drive a solenoid load of up to 50 v at 150 ma. A diode in each circuit suppresses inductive kick. Power requirements for Model SD-102 are +20 v at 12 ma, −90 v at 4 ma. Input requirements are approximately 0.5 ma into a 30 k input impedance. **Computer Control Co. Inc.**, 983 Concord St., Framingham, Mass.

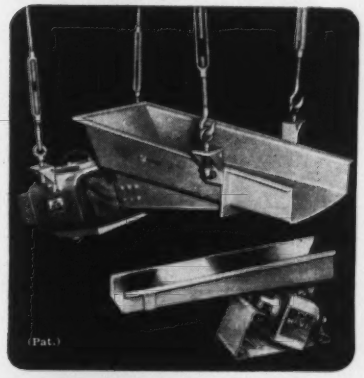
Circle 452 on Page 19

Pressure Balance

Miniature, precision pressure balance is designed for use with company's pressure measuring system.

ACCURATE AUTOMATIC FEEDING

from ounces to tons per hour



ERIEZ HI-VI VIBRATORY FEEDERS

Only feeders with totally enclosed drive element as standard construction. A-C operated, electro-permanent magnetic drive

Continuous, uniform flow of feed of all sizes and shapes of bulk materials for blending, mixing, sorting, cooling, etc. Variable feed rate. Completely automatic, extremely accurate. Increases production, provides quality control, reduces maintenance and operating costs.

Fully enclosed drive element (standard—no extra cost) makes units dust and moisture resistant; ideal for sanitary applications. Break-resistant glass fiber springs • New patented magnetic drive provides greater feeding capacity than comparable size units • No rectifier needed • Simple installation • Factory pre-tested • Fully proved in plants everywhere

NOW AVAILABLE! . . . economical, specially constructed units for hazardous dusty locations . . . fully acceptable by Mill Mutual.

WRITE FOR FREE COMPREHENSIVE LITERATURE
Eriez Mfg. Co., 119-CB Magnet Drive, Erie, Pa.

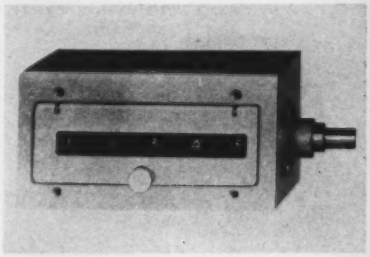
ERIEZ

Circle 713 on Page 19

It is applicable for automatic process control, testing and calibration of pressure measuring instruments, and measuring tank level pressures remotely. Seven pressure ranges are available from 0-1½ to 0-150 psi differential. Output of the transducer is ±100 v full scale. Combined effects of linearity and hysteresis are less than 0.05 per cent. The transducer portion of the system can be downranged to 10 per cent of its rated pressure without loss of accuracy and still provide ±10 v at this suppressed range.

In operation, any bellows displacement caused by a pressure differential is sensed by a differential transformer whose output is connected to a standard servoamplifier and power supply. The servoamplifier assembly null balances the system, and provides an electrical output in proportion to input pressure for visual or printed readout or continuous control. Response time of the high-speed system is 0.1 second full scale. **Transducer Div., Consolidated Electrodynamics Corp.,** Monrovia, Calif.

Circle 453 on Page 19



Contacting Counter

Instrument, designed for telemetering shaft rotation and position, is available with either 3, 4, or 5 wheels, each indexed from zero to 9. The unit is furnished in two series. The 1100 series has electrical contacts which correspond with each number on each wheel. The 1200 series has precision resistors mounted between contacts which form a stepped potentiometer or voltage dividing network, with the resistance ratios directly proportional to the visual indication. **Photocon Research Products,** 421 N. Altadena Dr., Pasadena, Calif.

Circle 454 on Page 19

NEW! FASTER RACKING

for conveying all Sizes and Shapes of Stampings, Parts, etc.

ERIEZ

permanent non-electric ERIUM-POWERED*

MAGNA-RAX

GET INCREASED CONVEYING EFFICIENCY. Magna-Rax magnetic power holds parts firmly in place while being conveyed . . . loading and unloading is faster . . . easier! One model will handle hundreds of sizes and shapes of parts . . . Magna-Rax are ideal for assembly line operations, where parts are conveyed from one point to another. Magnetic strength firmly holds parts while many operations such as tack off, dipping, spray painting, coating, degreasing, washing, inspecting, etc., are being performed . . . no need for special holes, lips, etc., on the parts as a means of holding.

Ideal for overhead or monorail systems. Rust and corrosion resistant . . . unaffected by temperatures up to 750°. Available in most any size and shape and with any number of Holding Magnets.

**Erium — an exclusive, high quality permanent magnetic power source specifically designed and energized by Eriez.*

Write for data on this exciting new product.
Eriez Mfg. Co., 119-CA Magnet Drive, Erie, Pa.

ERIEZ

Circle 714 on Page 19

For continuous thru-put and inventory data—W-C CONVEYOR-SCALE SYSTEMS

With a W-C Conveyor-Scale System incorporated in your process scheme, you can have up-to-minute thru-put data at any point from incoming transfer to inventory stock-pile. This data, expressed in terms of weight per unit of time, can be totalized for inventory records, process programming, or other manufacturing and accounting functions.

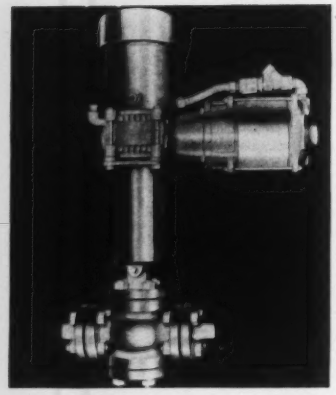
W-C Conveyor-Scale Systems can be supplied for flat or trough-type belts, fixed or variable speed, in capacities from 20 to 1000 tons per hour for new or existing conveyor installations. Each is a job engineered system employing standard, unitized components. As a result, you get a "custom" system at an "off-the-shelf" cost.

Typical applications include: Controlling feed and blending of formulation materials such as naptha, phosphates, metal ores, etc.

Write for new Bulletin 60

WEIGHING & CONTROL COMPONENTS, INC.
Div. of CompuDyne Corp.
E. County Line Road • Hatboro 12, Pa.
U.S.A. 2048

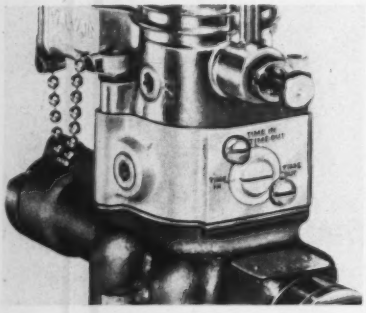
Circle 715 on Page 19



Valve Operator

Electronic process control valve operator is capable of stroking speeds up to 3 seconds per inch and response is without valve position hysteresis. It is adaptable to all electronic process controllers as the motor starting, stopping, and reversing control are completely electronic operations. Operator is adaptable to plug, butterfly, gate valves, or control valves. Stroke lengths and speeds are available for all valve sizes and process requirements. **Electronics Div., Industrial Process Engineers Inc.**, Newark, N. J.

Circle 455 on Page 19

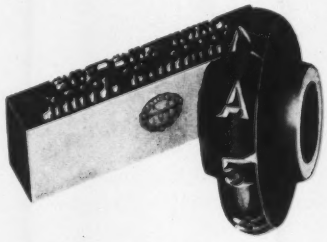


Timing Sequence Head

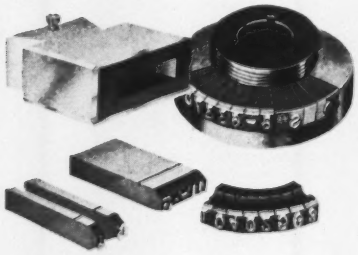
Applicable in circuits where time delay in valve function is required, universal timing sequence head provides delay up to 30 seconds on time in, time out, or time in and out. By connecting an accessory reservoir to the port provided in the head, delay can be extended up to several minutes. A micro-threaded metering pin in the side of the head is used to set the desired delay interval. Repeatability

MARKING DIES

Matthews Press Stamping Dies are machined, engraved, and heat treated from a choice of over 50 grades of tool steel to provide the most suitable marking for your application.



Roller dies and Flat Roll dies provide the finest marking with the least effort. Precision engraving of correct side bevels provides stress free marking and long die life.



Holders and type for flat and roll marking designed with the same exactness are ideal where frequent changeover is required.

For further information write

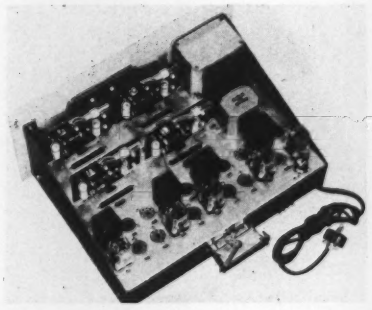
JAS. H. MATTHEWS & CO.
3962 FORBES AVENUE
PITTSBURGH 13, PA.

Circle 716 on Page 19

is within 2 per cent.

The valve function can be changed in seconds without disassembly of the valve or head, and with line pressure on the unit, by loosening the lock screws, turning the indicating plate to the desired function mark and then tightening the lock screws. The sequence head is available in two types, one for direct mounting between the pilot and the valve body; the other for direct mounting on the valve body, but with a remote pilot control. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 456 on Page 19



Telemetering System

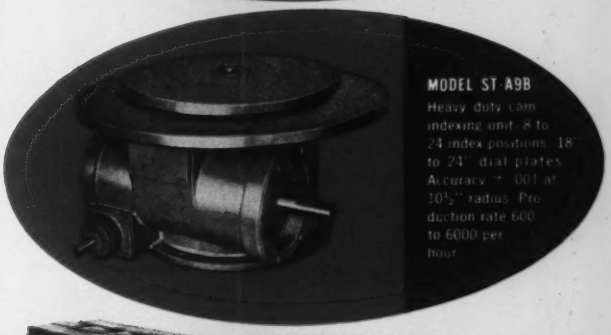
Transistorized telemetering system is capable of transmitting *On-Off* indications from remote stations to a central location, using existing telephone lines or audio circuits. From one to ten telemetering modulators are used whose tone outputs are transmitted over the telephone line to a telemetering demodulator. As many as twenty modullators and two demodulators can be used on a single telephone line. Audio tones in the range from 200 to 450 cps are used. Adjacent tones are normally spaced 10 cps apart, with harmonics of 60 cps excluded. Interference with normal telephone use is prevented by a band-rejection filter which blocks the tone frequencies, but passes ringing and voice frequencies. An interline coupling filter is also available. This perimts transmission of tones from one telephone line to another.

The modulator will operate on 6 to 8 v dc. It can be mounted in any position as all connections and operating controls are accessible from one side. The ambient operating temperature range is from 10 C to 50 C. The demodulator unit con-

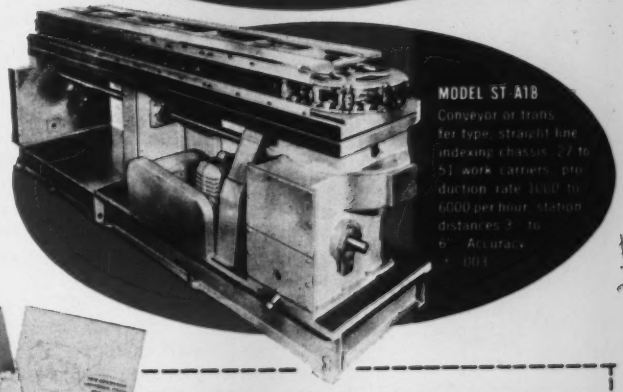
You can
PRODUCE & ASSEMBLE *Automatically*
when your machine is designed around a Standard Tool
INDEXING UNIT

The Heart of Automatic Machines

MODEL ST-A9A
Compact light to medium duty cam indexing unit. 8 to 20 index positions, 90° to 270° cams. 13½" to 24" dial plates. Accuracy ± .001 at 8" radius.



MODEL ST-A9B
Heavy duty cam indexing unit. 8 to 24 index positions. 18" to 24" dial plates. Accuracy ± .001 at 10½" radius. Production rate 600 to 6000 per hour.



MODEL ST-A18
Conveyor or transfer type straight line indexing chassis. 27 to 51 work carriers, production rate 1000 to 6000 per hour, station distances 3" to 6". Accuracy ± .003

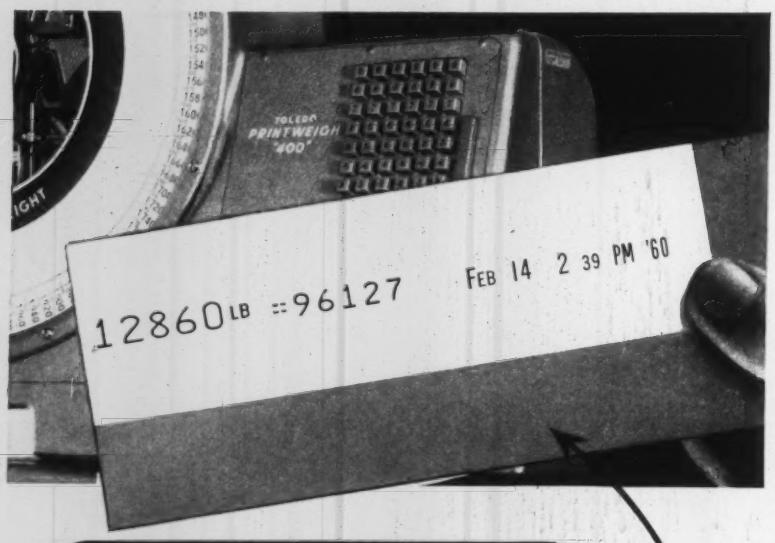
Technical Booklets Sent on Request!

Standard Tool engineers will be pleased to help you in selecting the indexing unit to meet your exact requirements.
Also ask for Standard Tool facilities brochure.

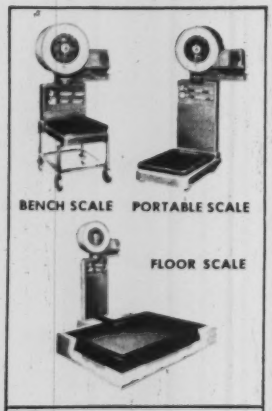
STANDARD TOOL & MANUFACTURING CO.
Machines for Shaping America's Future
240 LAUREL AVENUE KEARNY, NEW JERSEY
STANDARD TOOL AUTOMATION
Since 1910

Circle 717 on Page 19

TOLEDO SCALES that PRINT Complete Weight Records for You . . .



. . . **THE ANSWER** to prevent "guesswork" and errors in cost control!



Toledo Printweigh Scales are available in a wide range of models, including Portable, Floor, and Bench types as illustrated; also Built-in, Hopper, Overhead Track and Motor Truck types.

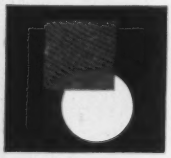
Human errors in reading, remembering and recording weights are eliminated with Toledo Printweigh "400" Scales. They're the surest way to satisfy your requirements for weight records that are complete and indisputable.

Weights are printed in full figures, even when unit weights are used. Choice of printing on 8½" x 11" forms, or on tickets; also on strips. Weight data may be transmitted electrically for recording on remote adding or other office machines. "Memory" feature available for printing weight data, even after load is removed.

Toledo Printweigh "400" Scales give new flexibility and efficiency in weighing . . . to cut costs, guard quality, prevent profit-stealing weighing errors. Ask your Toledo representative for the full story on Printweigh Scales, or WRITE TODAY FOR BULLETIN 2017. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio
(Toledo Scale Co. of Canada, Ltd., Windsor, Ont.)

"MISFIT" SCALES MULTIPLY COSTS

Scales can become "misfits" as a result of changes in plant layout, materials handling, inventory controls, value or quantity of materials weighed. If this has happened in your plant, the results can be costly. For example: weighing errors, production bottlenecks, materials handling inefficiencies. Be sure your scales are adequate for the job. Ask your Toledo representative about a scale adequacy check in your plant, or send for the Toledo Weight Fact Kit.



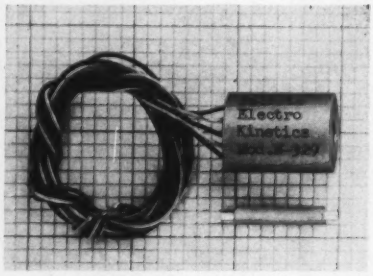
SERVICE

TOLEDO® *Headquarters for Weighing Systems*

Circle 718 on Page 19

sists of a bridging transformer and common amplifier which drives up to ten vibrating reed electromechanical filters. The output of each filter is amplified and limited to operate a sensitive thermal relay. The relay actuates an output indicator relay. A squelch circuit operates during the application of a telephone ringing voltage to prevent false actuation of any output relay, while maintaining previously established ouput indications. **Dualex Div., Bell & Gossett Co.**, Morton Grove, Ill.

Circle 457 on Page 19



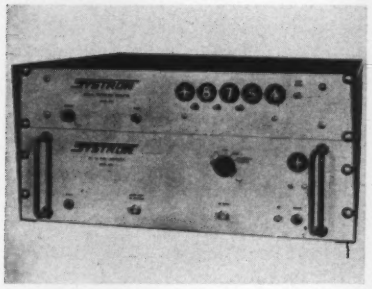
Miniature Transducer

Miniature transducer is suitable for use in computers, pressure sensing devices, and industrial applications. It has an input voltage of 26 v at 400 cps with a sensitivity of 60/mv/0.001-inch with a nonlinearity of 0.1 per cent over a range of ±0.010-inch. Operating temperature range for Model N-329 is −65 to +220 F. Dielectric strength between windings and between windings and housing is 500 v dc. The unit housing is cold-rolled steel, cadmium plated; the probe is cadmium plated with an extension of aluminum alloy. **Pacific ElectroKinetics**, 329 S. Vermont Ave., Glendora, Calif.

Circle 458 on Page 19

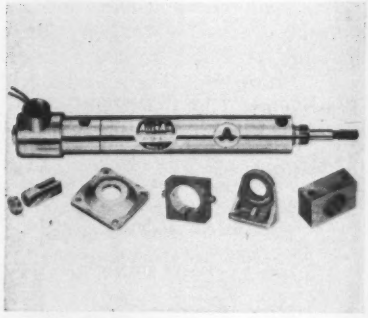
Digital Voltmeter

Suitable for automatic component testing of diodes, capacitors, and resistors, electronic digital voltmeter provides a 4-digit indication from ±0.0001 to 99.99 v, with optional ranges down to 1 mu v and up to 1000 v. Features of Model 1231 include: Accuracies to better than 0.05 per cent, 20 millisecond con-



version, and in-line readout. A crystal controlled 1 megacycle frequency is counted on four 50,000 hr rated life beam switching decades for the precise time interval proportional to the positive or negative input voltage. Superior linearity in the ramp, negligible zero and slope drift and 1 microsecond resolution in the purse generating discriminators are secured in this time modulation system. **Systron Corp.**, 950 Galindo St., Concord, Calif.

Circle 459 on Page 19



Valve-in-Head Cylinder

Single acting cylinder features a 3-way solenoid valve built into the rear head. It is available in two models. Model AVSA (shown) is designed for gravity or air return. Upon energization of the solenoid valve the piston rod goes out and stays out as long as current is maintained. This unit is furnished in stroke lengths up to 80 inches. Model AVSR has an internal spring to return the rod. A spacer tube is also installed in the front end of the cylinder to stop the piston so it will not compress the spring completely. Mounting styles for both models include: Flange mount, trunnion mount, foot mount, and block mount. **Allenair Corp.**, 255 E. 2nd St., Mineola, N. Y.

Circle 460 on Page 19

POSITIVE CONTROL OF MATERIALS IN MOTION BIF METERS FEEDERS CONTROLS

B-I-F BELT WEIGHER SOLVES PROCESS MEASUREMENT AND CONTROL PROBLEMS

- Checking production line output
- **Checking in-plant inventory**
- **Weighing incoming and outgoing bulk shipments**
- **Evaluating process efficiency**
- **Density checking**
- **Batch weighing**
- **Signal producing for pacing additive materials proportional to a variable flow**

CASE STUDY No. 1

BIF Omega **Pneu-Weigh Belt Weigher** checked production line output of 50 volumetric feeders to maintain critical limits . . . reduced plant downtime, lost man hours and production holdups!

Each feeder on proportioning line of a major formulator was putting out particular fraction of formula on continuous basis. Pneu-Weigh, installed at end of collector conveyor to "watchdog" operation through remotely located instrument, indicated less-than-expected output. A check revealed delivery rate of one volumetric feeder crtically lower than its limit. Result: over 100 tons of formulated product saved from being remade at considerable expense in plant time, man-hours, planning, removal of paper-bag packages, and subsequent resacking.

You'll find opportunities for cutting costs and improving efficiency in process feeding when you consult B-I-F — manufacturer of the most complete line of solid and liquid feeders and weighers.

B-I-F Industries

BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA

METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

Pneu-Weigh offers extremely high accuracies, wide ranges, capacities in compact, uncomplicated unit. Request Bulletin 36.20-1 for details. Write **B-I-F Industries, Inc., 527 Harris Avenue, Providence 1, R. I.**

Circle 719 on Page 19

All Mathews conveyer systems aren't this spectacular, but they all deliver outstanding performance

• It's true that everyone can't use an order-selecting system like this — but — it's also true that everyone specifying conveying equipment has a right to expect this type of *outstanding performance.*

You can have the benefit of well-planned mechanized handling in *your* plant. Mathews Engineers would like to work with you in developing a conveying system that will create a smooth flow of *your* product — a system that will deliver outstanding performance *for you.*

GENERAL OFFICES ..... MATHEWS CONVEYER COMPANY
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WESTERN DIVISION ..... MATHEWS CONVEYER COMPANY WEST COAST
San Carlos, California
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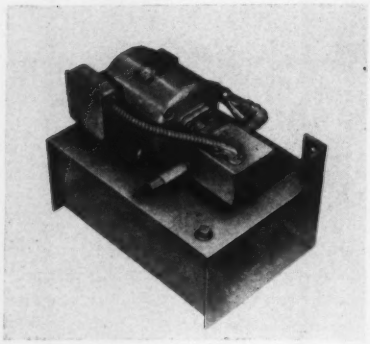
Port Hope, Ontario, Canada

Over Fifty Years of Leadership in Mechanized Handling

MATHEWS

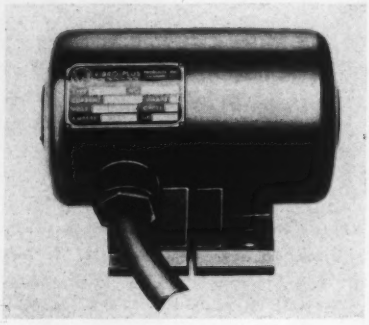
Circle 720 on Page 19



Hydraulic Unit

Hydraulic power package provides 1½ gpm output at 2000 psi. It is adaptable for press duty, machine feeds, lift tables, as pushers and punchers, or for any intermittent or jog duty applications. A feature of the unit is a precision gear-pump that is directly coupled to a special design electric motor. The motor is capable of producing up to 3 hp output at its duty rating. Other features are adjustable relief valves, ball check valves, and removable screen suction filters mounted on a 4½ gallon oil reservoir. **Autoquip Corp.**, 1140 S. Washtenaw, Chicago 12, Ill.

Circle 461 on Page 19



Bin Vibrator

Compact bin vibrator (Model ER-100) can be used on bins, hoppers, screens, and chutes, as well as in prestressed concrete work, pipe and tile production, block machines, or vibrating tables. Provisions can be furnished for either fixed or portable mounting. A range of voltages from 110 to 550, with one, two, or three phase current is available. **Vibro-Plus Products Inc.**, Stanhope, N. J.

Circle 462 on Page 19

PRECISION:

Reason enough to buy LeBlond

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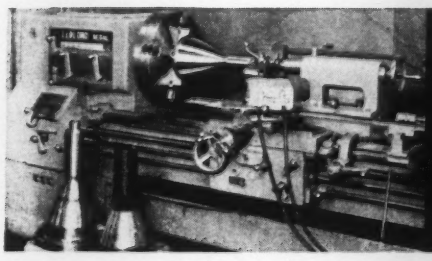

THE R. K. LeBLOND MACHINE TOOL COMPANY
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LeBLOND *of Cincinnati*

Circle 721 on Page 19

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Pumps & Controls

Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus, Ohio—72 *page catalog*—Pumps and controls which provide hydraulic power to 5000 psi are described in Bulletin 220. Kinds of units described include: Axial piston and vane type pumps, axial piston and vane type fluid motors, 4-way directional control valves, check valves, electrohydraulic pressure control valves, pilot operated pressure control valves, surge damping valves, and flow control valves. Performance charts and component characteristics are included.

Circle 463 on Page 19

Metering Pumps

Process Equipment Div., Lapp Insulator Co. Inc., 112 Hall St., LeRoy, N. Y.—28 *page catalog*—Metering pumps designed for handling corrosive and noncorrosive liquid chemicals are described in Catalog 59. The unit, designated Pulsafeeder, can be used as a pump, a chemical feeder, a meter, a proportioner, or a gas compressor. Notes are given on the operation of the pumps and the various types of reagent heads available for metering difficult fluids. Tables list capacities, sizes, and specifications.

Circle 464 on Page 19

Precise-Power Systems

Electric Specialty Co., 211 South St., Stamford, Conn.—32 *page catalog*—Bulletin 59-P describes precise-power sets which are rotary electromechanical systems regulated or controlled by static circuitry. Some of the applications described include: the application of precise-power sets to large electrieal systems; motor-alternators for ac-ac power conversion; and motor-generators for ac-dc power conversion. Numerous wiring diagrams and block diagrams are given.

Circle 465 on Page 19

Bin Level Control Switches

Stephens-Adamson Mfg. Co., Ridgeway Ave., Aurora, Ill.—4 *page pamphlet*—Bin level control switches are described in Bulletin 159. Data are given on three styles—normal duty for light to medium weight granular material; explosion-proof for hazardous materials and atmospheres; and heavy-duty for severe operating conditions and lumpy materials. Schematic drawings show two arrangements.

Circle 466 on Page 19

Pressure Monitor Systems

Technical Industries Corp., 389 N. Fair Oaks Ave., Pasadena, Calif. — 5 *page pamphlet*—Subject of booklet is Model 203A, a precision digital pressure measurement and control system, designed for the continuous measurement of pressures for long periods of time. Components in the system are described, and a block diagram shows the interconnection of the pressure transducer, power supply, preamp, and amplifier modules.

Circle 467 on Page 19

Variable Speed Pulleys

Hi-Lo Mfg. Co., Affiliate, Lovejoy Flexible Coupling Co., 4949 W. Lake St., Chicago 44, Ill.—24 *page catalog*—Bulletin HL-60 describes line of variable speed pulleys ranging from fractional to 5 hp, with speed ratios from 1.75:1 to 2.6:1. Five wide V-belt pulley models with speed ratios of 3:1 and two high-ratio types with ratios up to 7.2:1 are also described. Data are given on related equipment such as compound drives, motor bases and frames, wide V-belts, and sheaves.

Circle 468 on Page 19

Air Control Valves

Cleveland Pneumatic Industries, 64 Old Orchard, Skokie, Ill.—2 *bulletins*—Line of hand, foot, air, and solenoid actuated air control valves is described in two bulletins. Bulletin 8100 outlines disc-type valves from ¼ through 1-inch pipe size and pilot-operated valves from ¼ through ¾-inch pipe size. Bulletin 8101 covers valves from ⅛ through ½-inch pipe size which are recommended for direct actuation of small cylinders and for use as pilot valves in sequence circuits.

Circle 469 on Page 19

Adhesives & Applicators

United Shoe Machinery Corp., 140 Federal St., Boston 7, Mass.—16 *page booklet*—Thermogrip, a cord-like hot melt adhesive is described. Data are given on both wheel and nozzle type adhesive applicators which can be used for bag and folded box making, carton closing, food packaging, adhesion of continuous business forms, book making, and moisture tight sealing of multiwall bags. Various formulations of the adhesive are discussed.

Circle 470 on Page 19

Electronic Typewriter

Remington Rand, Div., Sperry Rand Corp., 315 Park Ave. South, New York 10, N. Y.—8 *page bulletin*—Subject of Bulletin RT 9006 is an electronic Synchro-Tape typewriter. Details are given on how the typewriter can be used in accounting procedures in small firms, medium-size firms, and large firms. Automatic features of this typewriter are compared with other common methods used.

Circle 471 on Page 19

Grate Coolers

Fuller Co., Catasauqua, Pa.—8 *page bulletin*—Bulletin CO-7 describes grate coolers which are designed for use where materials must be cooled after processing in rotary kilns, sintering machines, roasters, and various types of furnaces. Data are given on two types of coolers—horizontal-grate and inclined-grate. Schematic drawings show the design and construction. Also discussed is a clinker breaker which is designed to work with the grate coolers.

Circle 472 on Page 19

Electrical Instruments

Weston Instruments Div., Daystrom Inc., 614 Frelinghuysen Ave., Newark 12, N. J.—24 *page catalog* — Catalog, entitled "World Standards", describes precision electrical instruments used for calibrating working equipment. Instruments include dc voltmeters and ammeters, ac or ac and dc voltmeters, ammeters, wattmeters, current transformers, and low voltage standardizing potential transformers. A section on

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Circle 722 on Page 19

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PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 723 on Page 19

transformer ratio and phase angle curves shows the necessary corrections for residual errors that instrument transformers can introduce in a measuring system.

Circle 473 on Page 19

Control Devices

General Electric Co., Schenectady 5, N. Y.—72 *page catalog*—Data are contained in Catalog GEC-1260D on line of control devices. These devices include motor starters (manual and magnetic), contactors, relays, solenoids, limit switches, and pushbuttons. Horsepower selection charts list motors from 1/4 through 200 hp and provide a quick selection of starters, heaters, and pushbutton stations necessary for control of these motors. Also included are wiring diagrams and dimensions.

Circle 474 on Page 19

Processing Equipment

Jeffrey Mfg. Co., 956 N. 4th St., Columbus 16, Ohio—12 *page booklet*—Processing equipment outlined in Catalog 978 includes feeders, conveyors, coolers, dryers, packers, weigh feeders, vibrating screens, bin check valves, and magnetic separators. Specific data are given on electric vibrating feeders, constant weight feeders, and dryers and coolers.

Circle 475 on Page 19

Magnetic Tape Recorder

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.—10 *page bulletin*—Subject of Bulletin 1576B is Type 5-752 magnetic tape recorder/reproducer which can accommodate seven different types of records and reproduce amplifiers for analog fm or pdm modes of operation. General characteristics and specifications are noted; operating features are also pointed out.

Circle 476 on Page 19

Thread & Form Grinders

Sheffield Corp., Dayton 1, Ohio—12 *page booklet*—Precision thread and form grinding machines described in Catalog TFG-11-59 are designed for both production and tool room thread and form grinding. Data are given on two styles—Model 101 accommodates maximum part lengths up to 12 inches and Model 103 handles workpieces up to 24 inches in length. Photos show different part applications, and notes are given on optional equipment and accessories.

Circle 477 on Page 19

Metering Pumps

Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.—12 *page booklet*—Positive-displacement, plunger-type pumps in capacities ranging from 0.65 to 2025 gph are described in Bulletin 420.200. The pump can be arranged so a single motor will drive one, two, or three drive units; with each drive unit accommodating one, two, or three liquid ends. Design and operation of the drive unit and liquid end are explained. Tables list capacity-pressure selection data.

Circle 478 on Page 19

Meter-Relays

Assembly Products Inc., Chesterland, Ohio—12 *page booklet*—Expanded scale meter-relays with accuracies of ±2 per cent are described. Construction features are noted and schematic diagrams show standard circuits, automatic reset circuits, and flutter circuits. Illustrations show the different styles available.

Circle 479 on Page 19

Heat Treating Units

Ipsen Industries Inc., 721 S. Main St., Rockford, Ill.—6 *page pamphlet*—Pamphlet T-19-C describes heat treating units designed for carburizing, carbon restoration, carbonitriding, neutral hardening, marquenching, normalizing, annealing, and brazing. Cross-section drawings show construction features of the equipment which operates at temperatures up to 2000 F. Tables list performance characteristics.

Circle 480 on Page 19

Cable Elevators

Conveyor Div., Hapman Corp., 630 Gibson St., Kalamazoo 6, Mich.—4 *page pamphlet* — Handling means, designated Hi-Lift Cable-Veyor elevators, are described in Bulletin H-556-A. They are vertical elevator conveyors used for wet or dry flowable bulk materials. Two types are illustrated—a standard unit with cup shaped steel flights and a special interlocking neoprene unit. Also included are dimensional drawings and sketches showing different receiving hopper arrangements.

Circle 481 on Page 19

Servomotors

Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.—16 *page booklet*—Line of Size 11 servomotor components is described. This includes data for 115 v, 400-cycle servomotors, adjustable velocity-damp and inertia-damp servomotors, and servomotor-rate generators. Dimensions, schematics, and torque-speed curves are also included.

Circle 482 on Page 19

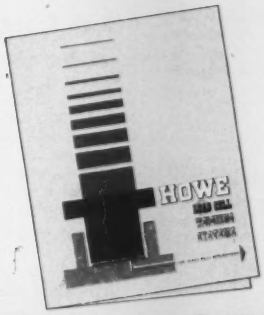
Fittings & Hose

Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio—8 *page bulletin*—Data are contained in Catalog 4482 on line of easy-to-assemble fittings and industrial hose for air, water, oil, and fuel service at pressures under 250 psi. Two types of hose are available in five sizes from ¼ through ¾-inch inside diameter. Fittings with seven different connecting ends are described.

Circle 483 on Page 19

Silicon Power Rectifier

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.—8 *page bulletin*—Silicon power rectifier described in Bulletin 6101-1A is a unified power conversion system consisting of a silicon rectifier unit, transformer, and associated auxiliary equipment. The unit, designated Unitron, is used as a source of direct current power for motors and electric arc



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Circle 724 on Page 19

furnaces. The water cooling system which uses de-ionized water in the rectifier section is explained.

Circle 484 on Page 19

Tracer Control Systems

True-Trace Corp., Dept. P1, P. O. Box 3307, El Monte, Calif.—4 page pamphlet—Bulletin SB-2 describes hydraulic tracer control systems for 1, 2, and 3 dimensional applications on machine tools. Also covered is Synchro-Trace, an automatic programmed 3D duplicating system. Notes are given on tracers, hydraulic cylinders, tracer mounting brackets, and tracer style sets.

Circle 485 on Page 19

Heat Treating Furnaces

Surface Combustion Div., 2375 Dorr St., Toledo 1, Ohio—8 page bulletin—Heat treating furnaces which use the power convection principle are described in Bulletin SC-182. The fundamentals and advantages of power convection are explained. Application photos are included, and schematic flow diagrams show typical systems.

Circle 486 on Page 19

Variable Transformers

Superior Electric Co., Dept. 10B, 83 Laurel St., Bristol, Conn.—8 page bulletin—Small variable transformers suitable for applications with relatively low wattage requirements are described in Bulletin P159. A cutaway photo shows the construction features. Outline drawings show dimensions and tables list connections and ratings for the 10B series.

Circle 487 on Page 19

Numerically Controlled Machine

Ex-Cell-O Corp., 1200 Oakman Blvd., Detroit 32, Mich.—20 page booklet—Basic information and the approximate costs of getting into tape controlled operations are given in Bulletin B5917. The fundamentals of numerical control are explained. Another point discussed is how different types of numerical control systems operate a machine tool. One section contains a series of questions and answers most commonly brought up when discussing numerical control.

Circle 488 on Page 19

Breadboard Parts

Component Div., Sterling Precision Corp., 17 Matinecock Ave., Port Washington, L. I., N. Y.—512 page catalog—Data are given in Catalog 61 on over 20,000 components. This includes adapters, bearings, brackets, brakes, cams, clutches, dials, gears, limit stops, mouting plates, pulleys, retaining rings, screws, shafts, terminals, washers, and wrenches for instrument and breadboard installations. Prices are listed for each piece of equipment.

Circle 489 on Page 19

Salt Bath Furnaces

Salt Bath Furnace Div., Lindberg Engineering Co., 2443 W. Hubbard St., Chicago 12, Ill.—8 page bulletin—Data are contained in Bulletin 151 on line of high and low temperature salt bath furnaces. Details are given on the submerged, built-in, water-cooled electrodes used in the furnaces. Notes are included on how the furnaces can be used for aluminum dip brazing, neutral hardening, annealing, and billet heating.

Circle 490 on Page 19

Quick Connect Couplings

Snap-tite, Union City, Pa.—4 page pamphlet—Five different styles of quick connect couplings ranging in size from 1/8 to 6 inches ID are described in Bulletin 8cSn. This includes couplings for high pressure applications up to 6500 psi; couplings designed for air service with reciprocating tools; couplings for vacuum and very low pressure; couplings for hard to handle fluids; and couplings designed for no-spill service. Charts list performance characteristics.

Circle 491 on Page 19

Radiation Detector

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Avenues, Philadelphia 44, Pa.—30 page catalog—Radiation pyrometry which is the art of measuring the temperature of an object by determining the quantity and characteristics of the radiant energy it emits, is discussed in Catalog C93-1a. Its theory

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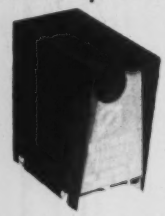
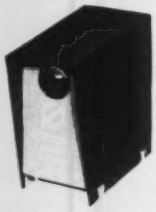
MODEL K-5 — Multi-Purpose Electronic Control counts up to 1000 units per minute





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Circle 725 on Page 19

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Circle 726 on Page 19

and fundamentals are explained and a condensed description of the principle of radiation pyrometry is given. Sketches show typical applications and suggestions are given on how to select the proper detector for a given application.

Circle 492 on Page 19

Remote Control System

Hydronic Corp., 12685 Arnold, Detroit 39, Mich.—4 page pamphlet—Engineering data are given on a closed hydraulic system for remote motion control or duplication. Features and dimensions are covered, installation information is listed, and notes are given on accessories.

Circle 493 on Page 19

Temperature Measurement

Partlow Corp., 532 Campion Rd., New Hartford, N. Y.—23 page booklet—Booklet entitled, "Industrial Temperature Measurement and Control," describes various methods of temperature sensing through mercury-bulb instrumentation. Subjects discussed include: Ways of responding to temperature; ways of putting temperature response to work; and nine basic types of controls. Principles of mercury-bulb installation are explained, and six case-histories are described to show what instrumentation can do.

Circle 494 on Page 19

Gas Sampling Systems

Hays Corp., Michigan City, Ind.—8 page bulletin—Method of selecting a gas sampling system to provide maximum, trouble-free gas sampling service is discussed in Bulletin 59-B651. The systems available are divided into a possible total of eight component package sections which can be assembled into 16,000 different combinations to suit any particular gas sampling problem. The four basic methods of sampling are explained, and installation and operating instructions are given.

Circle 495 on Page 19

Flow Control

Brooks Rotameter Co., Hatfield, Pa.—8 page bulletin—Rotameters for corrosive service are outlined in Bulletin 150. Details are given on the materials used in manufacturing the meters for different applications. A cross-section drawing shows gland details, and other drawings show the various types of meters and extensions.

Circle 496 on Page 19

Digital Tape Handler

Instrumentation Div., Ampex Corp., 934 Charter St., Redwood City, Calif.—8 page bulletin—Subject of booklet is Model FR-400, digital magnetic tape handler which has an instantaneous selection of 75 or 37½ ips tape speed. Mechanical highlights of the system are noted and photos show the assembly process. Specifications are given for machines which are available with ½, ¾, or 1-inch tape, providing up to 32 data channels.

Circle 497 on Page 19

Switching Transistors

CBS Electronics, 100 Endicott St., Danvers, Mass.—9 data sheets—Line of transistors described in Bulletin E-353 consists of 25 computer types suitable for logic-circuit, core-driver, and other switching applications. Data are given on units with alpha cutoff frequencies ranging from one to 17 megacycles and maximum dissipations from 50 to 150 milliwatts.

Circle 498 on Page 19

Heat Exchangers

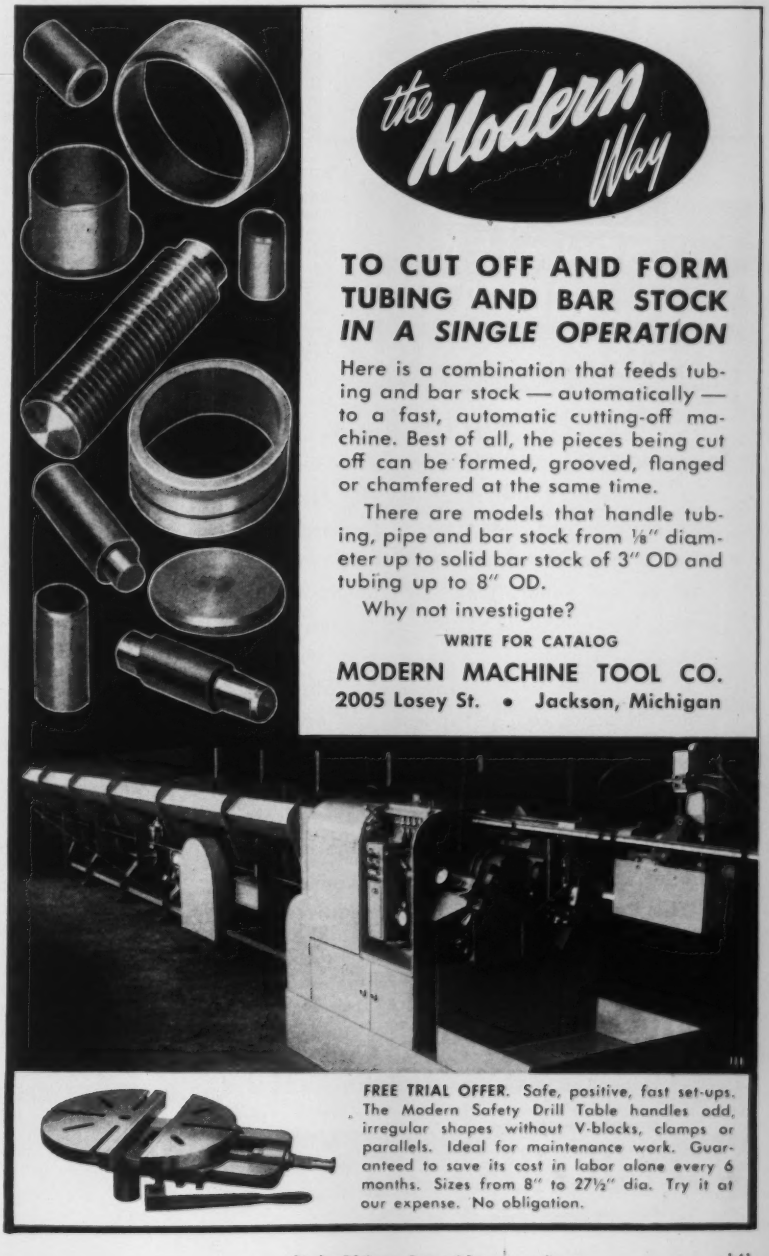
Young Radiator Co., Racine, Wis.—15 page booklet—Shell and tube heat exchangers are described in Catalog 1258A. Types of units include single-pass, two-pass, and four-pass models for cooling water and oil in fresh or salt water applications. Suggestions are given for selecting the proper heat exchanger. Charts show pressure ratings and oil viscosity.

Circle 499 on Page 19

Valves and Accessories

Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio.—8 page bulletin—Data are given in Bulletin 91021 on in-line accessories such as strainers, pressure regulators, flow controls, sequence, and quick exhaust valves for air, oil, gas, steam, etc. Design features of the individual units are noted, as are ordering instructions.

Circle 500 on Page 19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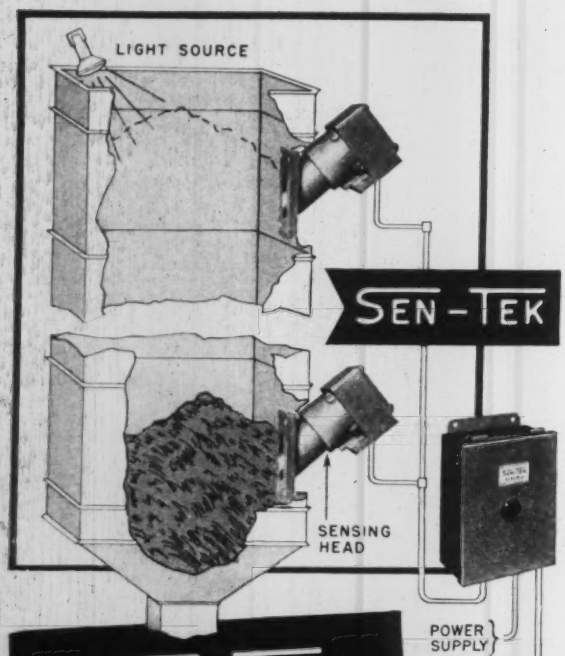
Circle 727 on Page 19



SEN-TEK LEVEL-INDICATING SYSTEM *Light-Sensing Type*

EUCLID Bulletin E-200

Sen-Tek Control, the electronic light-sensing device, detects and controls the level of opaque and solid materials. It detects levels of such materials as foundry sand, powdered coal, carbon, sugar, flour, salt and grain—or heavy, bulky materials such as stones, slag, coal, coke and ore.

It installs easily on bins, tanks, hoppers, grain elevators, etc., as top-level and bottom-level indicators. Or it may be used as either a top or bottom-level indicator.

What's more, it can be used as a limit switch, counter, indicating device or for similar applications.

The Euclid Sen-Tek Control requires no warm-up time, has no filaments to fail and does not lose sensitivity with age.

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EX-19

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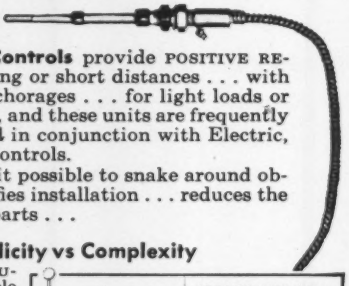
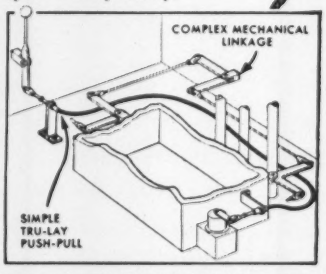


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

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Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when conduit is COMPLETELY IMMERSED.

Lubrication of the inner working member is for life.

Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

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AUTOMATION abstracts

COMMENTS ON JIC ELECTRICAL STANDARDS

By JOHN ZAMBRZYCKI
Engine Manufacturing Engineering
Engine and Foundry Div.
Ford Motor Co.
Dearborn, Mich.

JIC ELECTRICAL standards intend to provide the highest level of personnel safety, to prevent machine damage, to assure proper part machining, to provide means for easy and efficient troubleshooting and, of course, to assure reliability of operation. Let us review some requirements of JIC electrical standards and see what means are used to achieve this goal.

Paragraph E.14.4.2-N reads — "When necessary, limit switches shall be interlocked by the use of both the normally-open and the normally-closed contacts to prevent damage caused by the sticking of the switch in tripped position." Each limit switch is used to perform a function. In most cases it shows the position of a machine component or machine part and thus sequences the machine operation. To determine when the "second" side should be used, it is indispensable to check the circuit for what will happen if the limit switch sticks in tripped position. The paragraph under consideration also explains the purpose of this requirement, "To prevent damage caused by sticking of the switch in the tripped position."

In *Fig.* 1 we have a circuit in which the second side of each limit switch is used, but the circuit does not protect the machine from damage in case of limit switch sticking.

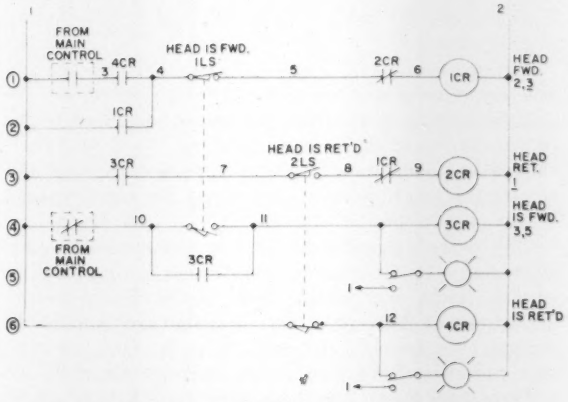

Fig. 1—Diagram illustrates a dangerous circuit that might have been used to interlock motions of one head with entire machine. Although both the normally-open and the normally-closed contacts are used on the limit switches, the circuit will not prevent misoperation if one of the limit switches sticks.

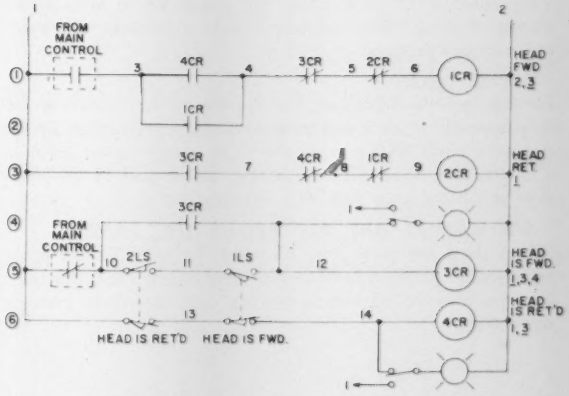

Fig. 2—Circuit indicated will provide safe interlocking of head motions and over-all machine even if one of the limit switches sticks. Such fail-safe operation is a goal of JIC standards.

When the head is returned, 2*LS* is tripped, and relay 4*CR* is energized. When a signal from the main control panel is received, relay 1*CR* is energized and the head moves forward. Suppose that 2*LS* sticks in a tripped position, the head moves all the way forward, and a signal from 1*LS Head is forward* is received, 3*CR* is energized, but 2*LS* in *Head return* circuit is open and the head cannot return. The head is forward, but the main control panel received a *Full depth* or *Head is forward* signal which is correct and a *Head is returned* signal, which is false. The machine will cycle and transfer with the head in forward position.

Let us consider the case when the *Head is forward* limit switch fails. The head is returned, a signal from main control panel is received, and head starts forward, full depth is reached, head returns, but the limit switch 1*LS Head is forward* sticks in tripped position. The machine maintains its cycle and a full depth circuit is opened by a signal from the main control (usually *Transfer moves forward*). The *Head is forward* limit switches mounted on all heads except the one under consideration are in proper position, the full depth indication in main control is canceled, all heads move forward except the one under consideration, but the *Full depth* indication from the sticking limit switch mounted on this head is present although false. Machine cycles and the part is transferred without being machined by the tools in the head under consideration.

In the circuit of *Fig.* 2, if 1*LS* limit switch sticks in tripped position, the signal *Head is returned* is not

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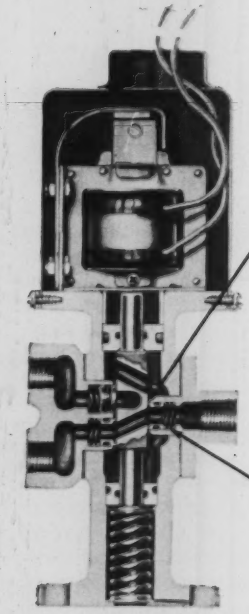
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present. If 2*LS* limit switch *Head is returned* sticks, the signal *Head is forward* is not present. In both cases the machine will stop cycling.

Now let us discuss *Paragraph E*.14.3.1-*B* which reads "Solenoids shall be relay controlled with separate contacts of the same relay connected in each lead of the same solenoid." In one version of a solenoid circuit, at lower left in *Fig.* 3, the relay contact is inserted in one solenoid lead only. In case of a ground on *Clamped* limit switch and another on *Transfer forward* solenoid, transfer will move forward every time parts are clamped. This will certainly damage the machine. If any two solenoids become grounded, both will be energized when the sequence calls for energization of one of them. In the JIC version of the solenoid circuit this kind of ground will not affect machine performance. If anyone should state that JIC standards do not fully protect the machine from damages caused by all kinds of grounds, he would be correct. Most of the grounds occur on solenoids and limit switches, and therefore the JIC method gives the machine a reasonable degree of protection against damages caused by grounds.

Someone could ask: "If there are so many troubles with grounds, why not use grounded circuits?" The answer is simple. If a ground occurs on the ungrounded side of a grounded circuit, the fuses will blow, and the machine cannot be put back into production until the unwanted ground is cleared. Automotive mass production lines cannot tolerate frequent machine stoppages. Usually grounds are cleared on weekends, when there is no production.

Now, let us turn our attention to *Paragraph E*.14.4.2-*A* which reads "All reversing starters, contactors controlling solenoids mechanically connected, and contactors controlling opposing motions, shall be protected from simultaneous energization."

This paragraph contains very important engineering advice to check the circuit for what may happen if any device fails. The circuit should be designed in such a manner as not to permit any machine damages due to starter, contactor or relay failure to de-energize at proper time. If, for instance, the relay *Clamps forward* is energized, the relay *Clamps return* cannot be in, and vice versa.

Paragraph E.14.4.2 reads in part: "Where starting and stopping of devices in improper sequence can result in a hazard to the operator or damage to the equipment or work in process, circuit shall be so arranged as to insure the proper sequence starting and stopping of such devices. For setup purposes manual means . . ."

This paragraph takes the human element under consideration. It tells us in very plain language that human errors are possible and circuits should be designed to circumvent them. Pushbuttons should be designed to the control circuit in such a manner that an improperly used pushbutton will not respond.

Paragraph E.14.4.2-*H* deals again with human weakness. It requires a so-called antirepeat circuit for machines where continuous consecutive cycles of operation are unwanted. *Paragraph E*.14.4.2-*G* requires a "two-hand trip" for the machine operator where hazardous movements are present. This requirement is intended to guard against operator laziness, which induces an

operator to lockout one pushbutton and use only the other.

*Paragraph E.*18.6.2 requires safety selector switches for each station on transfer-type machines and automatic equipment. The selector switches shall be interlocked with the main control station in such a way as to make the main control ineffective when switches are in *Safe* position. This requirement is intended to ease tool changing or tool setup as well as to give protection to the man at work.

*Paragraph E.*18.6.2 requires safety selector switches shall be initiated through de-energization. In our division we believe that *Emergency return* which returns all heads and eventually stops the machine operation, shall be also initiated by de-energization.

This paragraph was challenged many times. There exists a well-founded opinion that normally-open relay contacts are more dependable than normally-closed. That is true. On the other hand an emergency device is used in emergency only. It cannot be checked automatically during machine cycling if it is intended

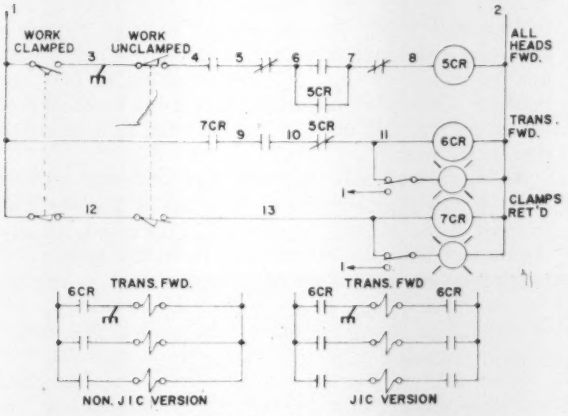

Fig. 3—In conjunction with the circuit shown at top, either one of the lower circuits might appear feasible to operate various solenoids. When accidental grounds are considered, the JIC version at lower right has considerable advantages in safety and decreased downtime.

to be de-energized during normal machine operation. If it has to be energized during normal machine cycling, at least we know that it is energized. When de-energized, it will drop out. If one normally-closed contact does not make, one head will not return, but all others will and all forward movements of the machine components will be interrupted.

For our use, we at Ford Motor Co. have our "Ford options to JIC electrical standards." Most of these options are devoted to listing the information which should be specified in the purchase order according to JIC. We specify in them our voltage, ungrounded control circuit requirement, how many copies of approval prints we need and so on.

But we also use these options in an "emergency." JIC standards cannot be changed every year. So if we feel that some requirements need immediate attention, we place them in our options. Right now they contain two important paragraphs: One requiring push-

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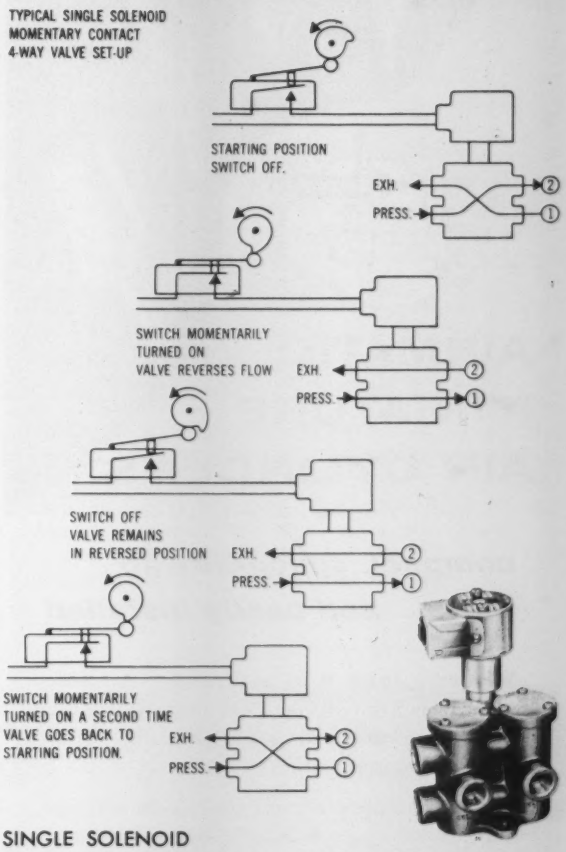
TYPICAL SINGLE SOLENOID MOMENTARY CONTACT 4-WAY VALVE SET-UP
STARTING POSITION SWITCH OFF.
EXH.
PRESS.
SWITCH MOMENTARILY TURNED ON VALVE REVERSES FLOW
SWITCH OFF VALVE REMAINS IN REVERSED POSITION
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SINGLE SOLENOID

Current is required only momentarily to change the position of the valve (two-position four-way and three-way valves). When the solenoid is energized the valve is actuated and remains in the actuated position after the current is off. On the next electrical impulse the valve is re-actuated (returned to its former position) and remains in that position with the power off.

DUAL SOLENOID

Dual solenoids prevent the valve from getting out of phase, particularly important in automated systems. If the same solenoid is energized twice in succession, the position of the valve will not be changed. The opposite solenoid must be energized to reverse the valve. Otherwise the operation is the same as described above for the single solenoid units.

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From a paper entitled, "Comments on JIC" presented at the 23rd Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp., Buffalo, April 1959.

FAIL-SAFE CIRCUIT FOR HYDRAULIC MACHINES

By B. A. OLMSTED
Chief, Product Engineering
Plastics Division
Package Machinery Co.
East Longmeadow, Mass.

SINCE the inception of injection molding, we, the machine manufacturers, have been plagued by the problem of safety. The machine by its very nature is a dangerous one. In the first place, there are dies being squeezed together under tremendous loads, molten plastic material being pushed around at high pressure, plus the additional fact that practically all operators are on piecework and will do anything to best the machine. One other disturbing fact is the monotony of the operation. All these things add up to a situation that spells trouble.

All machinery manufacturers have provided various types of safety arrangements. The use of a safety gate in front of the die area is universal. This gate is usually interlocked with the electric and hydraulic systems by various means. All of these means attempt to control the movement of the die platen. Unfortunately, all of these safety devices are only as good as the maintenance provided.

For example, let's look at a system that provided a cam-operated pilot 4-way valve, interlocked between the solenoid pilot valve and the die 4-way valve. This system also provided a limit switch operated by the safety gate. The switch provided that the solenoid valve could not be energized until the gate was closed. The cam-operated 4-way valve was also operated by the gate and provided that, as long as the gate was open, the dies could not close. Now let us suppose that the lever that operates the cam-operated pilot valve is out of adjustment so that the valve does not perform its function. The press will continue to operate, but the only safety now is the limit switch.

Within the past few years a device known as a drop bar came into being and has received wide acceptance. This is a simple bar that is controlled by the safety gate. With the gate open, the bar is between the die platens and the action of closing the gate raises the bar out of the way.

This drop bar is only a safety device in the extreme open position of the die platen. If the press were opening and something happened to cause the press to close again or the press had been initiated to close and the operator suddenly opened the safety gate, the drop bar would not stop the press as it would be unable to drop between the platens.

We incorporated a different type of safety on the

machines. It consisted of two limit switches actuated by the safety gate, rather than a single limit switch and the cam-operated valve. We interlocked an additional solenoid valve between the pilot and slave of a piggy-back 4-way valve. This valve was manifolded in such a manner that the slave valve could not shift until the interlock valve was energized.

However, we had found one fault with this system. Although we could check either pilot valve by operating the limit switches independently, we found that in operation this was not being done. Therefore, the interlock valve could stick in the energized position, and the press would continue to operate with one-half of its safety lost. Our only answer was to monitor this valve. We decided that, if we could mount a limit switch on the spring offset end of this valve and monitor the shifting of the spool, we would have what we wanted.

Our one source of possible trouble was if the slave main spool became stuck. We had no way of monitoring or controlling this. That is, if the press were initiated to close, then the gates were opened, and if the slave valve spool became stuck at that instant, the press would continue to close and the operator would in all probability get seriously hurt.

We found that the most likely way it could happen would be the following: The operator closes the gate, the press starts to close, the operator notices that the dies are not clean, and he opens the safety gate, expecting the dies to stop. If the slave valve stuck at this particular moment, the operator would be hurt. This evaluation led us to our solution. We reasoned that if we could keep the operator out of the press until it became safe, we would have what we wanted.

A spring return hydraulic cylinder was arranged to raise a block in front of the safety gate. The action of the system pressure acting on the clamp cylinder head also causes the spring return cylinder to raise the block.

Now let us suppose that the operator wants to stop the press because of some obstruction in the mold. He can open the gate only far enough to break the contacts on the two safety gate limit switches. The spring return cylinder prevents further movement until the slave valve has centered and the machine is safe. Then the gate can be fully opened to remove the obstruction. In other words, we prevent the operator from getting between the platens until the machine is at rest.

The two limit switches on the safety gate and the one on the interlock valve are set up so that, on semi-automatic operation, each one must close and open on each cycle of the machine. If any one stops in the closed position, due to welding of the contacts or because the interlock valve spool has stuck in the energized position, the press will open and stop. This trouble must be found and corrected before machine can be put back in operation.

From a paper entitled "Fail Safe Safety Circuit On Injection Molding Machines" presented at the Third Fabricating Machinery Hydraulic Conference sponsored by Vickers Inc., Detroit, April, 1959.

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PROCESSING WHILE CONVEYING

By JOHN FISCHER
Chief Engineer
Materials Handling Div.
Sprout, Waldron & Co.
Muncy, Pa.

PNEUMATIC CONVEYING is becoming increasingly significant and economically worthwhile for all free-flowing and relatively dry materials such as powdered and granular chemicals, grain and foodstuffs, plastics, and ores. Among the advantages are flexibility, cleanliness, safety, and ease of automation.

For many applications, pneumatic conveyors have higher capital cost and generally higher horsepower requirements which tend to limit their use. On the other hand, there are many potential uses, supplemental to conveying, which can frequently supply the economic justification for an otherwise costly method of material transfer. Frequently, it is also possible to achieve some control over a supplementary function which otherwise would be impractical.

The most commonly used secondary purpose of pneumatic conveying systems is heat transfer. Cooling, because of technical difficulties, is less frequently considered than heating or drying.

Heat transfer in a pneumatic conveying system is generally a problem in convection. To properly understand this, it must be remembered that nearly all pneumatic conveying systems which are used for heat transfer as well as conveying are so-called dilute or low-density systems. The ratio of solids to gas is relatively low.

In a cooling system, the direction of heat flow is reversed. The factors of diffusion, particle size, and specific heat are the same, but considerably more air must be used. For this reason, pneumatic cooling systems have been more difficult to justify economically. If the material contains an appreciable amount of moisture, the control necessary to prevent condensation and fouling of the conveying line often makes cooling impractical. With essentially dry material, the addition of small amounts of moisture to the conveying air facilitates cooling but requires day-to-day and hour-to-hour control based on the variations in atmospheric humidity.

Drying is also a heat-transfer operation. Sufficient heat must be provided in the conveying air to vaporize the desired amount of water from the material being dried. The drying of flour, plastics, and bark are among the many interesting applications. Essentially, each of these systems—originally designed on a purely empirical basis—involves flash drying. Where any substantial conveying distance is involved, the factor of equilibrium moisture content comes into very obvious and annoying existence.

Since 1000 Btu are required to evaporate 1 lb of water, in general, the quantity of water to be removed from the material, times the Btu per lb, provides the amount of heat that it is necessary to put into the conveying air. Again, an efficiency of 50 per cent should be used for the heat-transfer system. This is a very broad generalization, which side-steps a tedious and sometimes involved calculation of humidity and equi-

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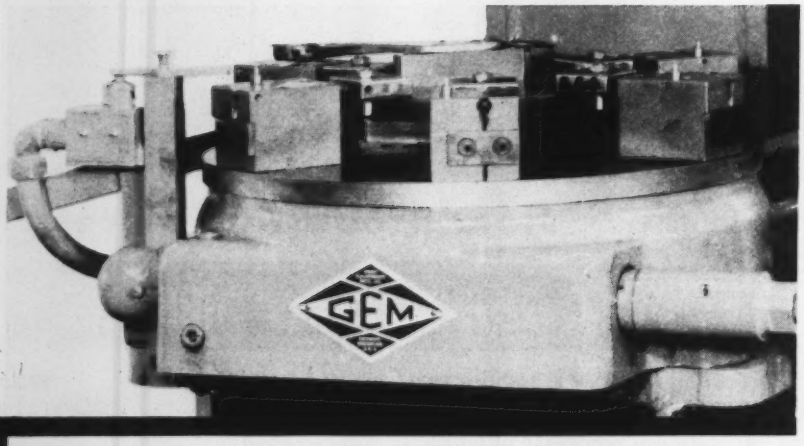

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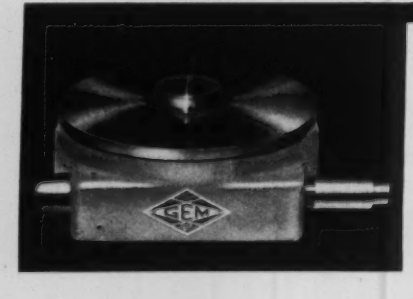

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librium-moisture content. It is effective for flash drying only and in cases where only partial moisture removal is required.

Complete or nearly complete moisture removal involves vaporization of bound moisture. Where high temperatures are not possible, particle size, velocity, and capillary action must be considered, and very long systems with relatively low temperatures are required.

Pneumatic conveying systems used for supplemental heat transfer are generally of the negative type, in which the conveying air is drawn into and through the system by a suction fan. A heating coil is placed across the air inlet to this system. The material is fed into the system through an airlock so that the amount of outside air drawn in is kept to a minimum.

Positive-pressure conveying systems, in which the motive source is at the inlet end rather than at the discharge end, are not generally used for heat transfer, because the ratio of solids to air which they handle is quite high. However, where extremely long conveying distances and small quantities of product are involved, heat-transfer units have been applied to positive-pressure conveying systems with considerable success.

Although to the author's knowledge, no one has ever specifically purchased a pneumatic conveying system for the purpose of size reduction, the potential use of these systems for breaking up material can best be illustrated by outlining the measures taken to prevent it.

Three factors are involved in breakage. They are: Conveying velocity, the number of changes of direction, and interior surface irregularities. Each of these results in impact which contributes to breakage.

Taking all these factors into consideration, it is well within the realm of probability that a pneumatic conveying system can be designed deliberately to increase the percentage of fines in the finished product. The conveying system cannot become an effective substitute for a hammer mill or an attrition mill, but within reasonable limits it can reduce further processing or processing time.

Virtually no separation of particle sizes or of mixtures of particles of different densities takes place in a pneumatic conveying system. Experiments confirming this have been conducted over a wide range of mixtures. However, in a properly designed cyclone collector, an effective degree of separation can be obtained.

The introduction of a controllable obstruction in the descending section of the cyclone will create a turbulence, causing re-entrainment of the finer particles into the inner vortex. Placement and design of this obstruction are empirical, requiring a degree of judgment regarding the approximate relative positions of heavy materials, light materials, and the ribbon of air. In the highly efficient long-cone type of collector used with a negative-pressure conveying system, it is frequently sufficient to provide a controlled leak near the bottom of the collector. Unusually effective separation of unwanted fines has been made by the methods described.

From a paper entitled, "Pneumatic Conveyors" presented at the Semiannual Meeting of the American Society of Mechanical Engineers, St. Louis, June, 1959.

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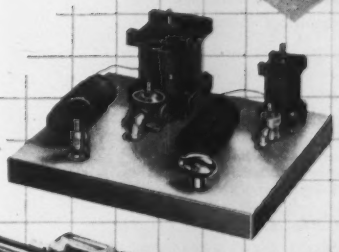

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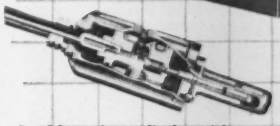
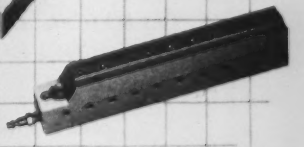
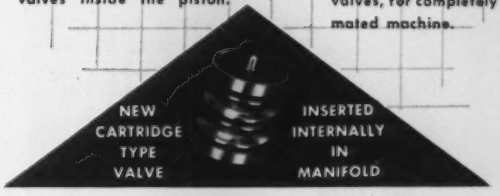


Double action cylinder with all manually operated valves *inside* the piston.



10-valve manifold using piloted ¼" and ⅜" insert valves, for completely automated machine.



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PRACTICAL DESIGN OF SHEET METAL STAMPINGS

By Federico Strasser; 175 pages, 6¼ by 9½ inches, published by Chilton Co., Philadelphia, Pa.; available from AUTOMATION; *$10.00 postpaid.*

The author summarizes a considerable amount of basic, practical information about metal stampings and stamping techniques. The book is divided into three sections: Basic Concepts, Details of Stamping Design, and Special Problems. Included in the latter section is a chapter devoted to methods of joining metal stampings.

ENGINEERING AND ORGANIZATION

By Everett Laitala, professor of industrial engineering, Case Institute of Technology; 391 pages, 6¼ by 9¼ inches, published by Richard D. Irwin Inc., Homewood, Ill.; available from AUTOMATION; *$7.20 postpaid.*

The goal of the engineering profession is to make the properties of materials and the forces of nature useful to man in structures, systems, manufactured products, and production processes. In accomplishing this goal in modern society, the engineer must be aware that he is essentially a team player, with responsibilities that overlap many other functions in a business. These points are discussed in this book in developing a rational basis for the systems concept in industry.

PROGRAMMING FOR DIGITAL COMPUTERS

By Joachim Jeenel, research associate, Watson Scientific Computing Laboratory, Columbia University; 517 pages, 6¼ by 9¼ inches, published by McGraw-Hill Book Co. Inc.; available from AUTOMATION; *$12.00 postpaid.*

In recognition of one of the major stumbling blocks to effective computer utilization, the author presents a methodical approach to the preparation of problems for stored-pro-

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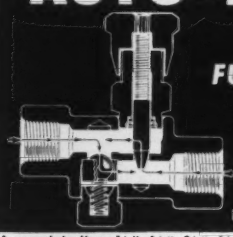

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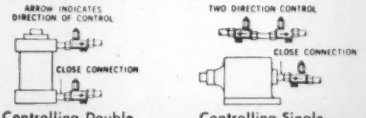

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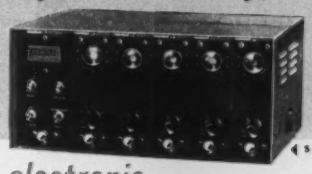

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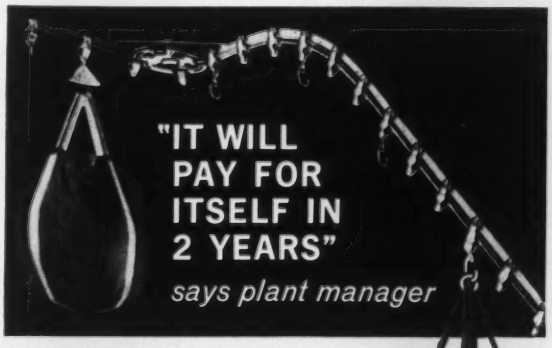

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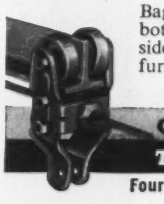

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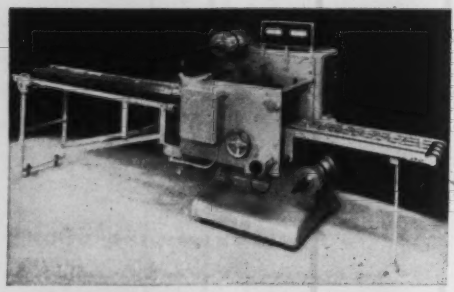

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PERSONNEL ADMINISTRATION: EVALUATION AND EXECUTIVE CONTROL

By James H. Taylor, vice president, Industrial Relations Counselors Inc.; 326 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$7.00 postpaid.*

The general importance of this topic is best presented in the author's words: ". . . We believe we are leaving an era of force, of a priori opinion, of arbitrary pronouncement, and of power of authority, to enter a period where relations with people will be guided more and more by the power of knowledge." The author has organized his discussion under five major sections: Management Succession; Compensation; Personnel Plans and Policies; Manager-Employee and Company-Union Relationships; and Your Personnel Philosophy and Your Personnel Man.

CONTROL ENGINEERING

By Gordon J. Murphy, associate professor of electrical engineering and industrial engineering, Northwestern University; 385 pages, 6 by 9¼ inches, published by D. Van Nostrand Co. Inc., Princeton, N. J.; available from AUTOMATION; *$7.50 postpaid.*

The author presents this work as an intermediate level coverage of automatic feedback control. It is designed to cover both elementary and advanced topics carefully and in some detail at the mathematical level so as to challenge the good student without unnecessarily interfering with his efforts to learn.

NOMOGRAPHY

By A. S. Levens, professor of mechanical engineering, University of California at Berkeley; second edition, 296 pages, 7 by 9¾ inches, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$8.50 postpaid.*

The book describes in detail how various types of nomograms are designed; the mathematical basis for the several types is covered in some detail. This second edition contains three new chapters on circular nomograms, projective transformations, and the relationship between concurrency and alignment nomograms with applications to experimental data.

ANALYSIS OF STRAIGHT-LINE DATA

By Forman S. Acton, associate professor of electrical engineering, Princeton University; 267 pages, 6 by 9¼ inches, published by John Wiley & Sons Inc.; available from AUTOMATION; *$9.00 postpaid.*

The author's basic thesis is that a realistic model is worth more than all blindly applied least-squares techniques in analyzing engineering data. He believes that the experimenter, rather than a professional statistician, is best suited to analyzing data because of the close relationship between the structure of the experiment and best method of data analysis. These thoughts have led the author to prepare a practical text that draws heavily upon actual cases in covering statistical techniques in some detail.

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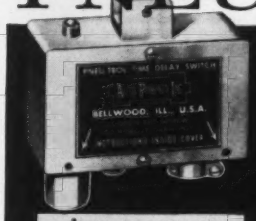

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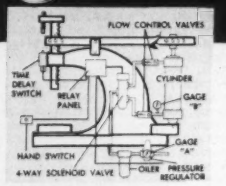

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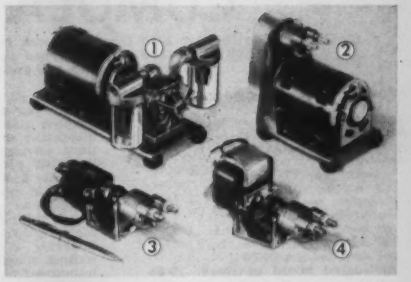

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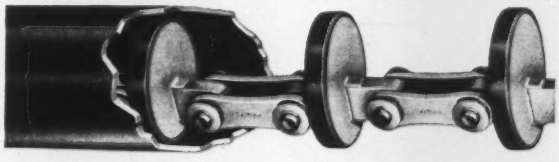

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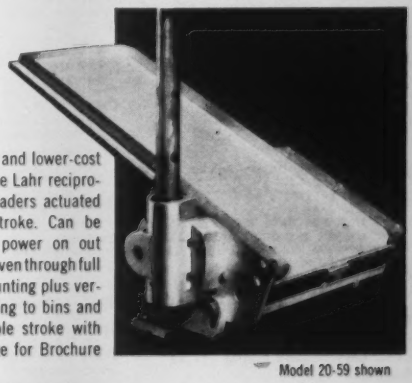

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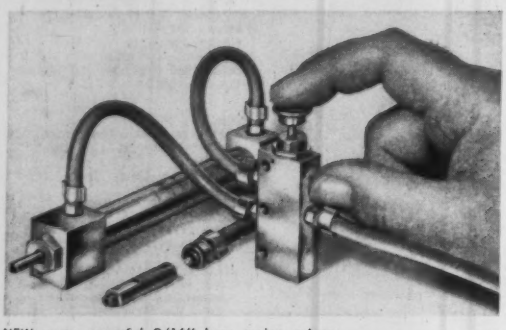

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Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2014-P

COLOR SORTING

. . . We would like to automatically sort raw peeled tomatoes by color into two grades. Our object is to distinguish between tomatoes red enough to make the Extra Standard-grade and tomatoes that fall into the Standard grade. By USDA regulations an Extra Standard tomato may not have less than 50 per cent of its surface area as red as "Tomato Red" (Maerz and Paul Dictionary of Color, Plate 3 I 12) and not more than 50 per cent of its surface area may be less red than "Tomato Red." As we feel we could design the necessary handling system, what we require is the necessary electronic and optical equipment to provide a signal for a go or no-go classification by color . . .

Vegetable Canner

CASE 2009-P

REUSABLE CORRUGATED CARTONS

. . . In packaging our products (glass items, bulk packed), four sizes of cartons are used. When the receiver empties the cartons, they are then collapsed by slitting the paper tape that holds the flaps together. The flattened cartons are returned for re-use. Prior to re-use, the cartons are formed, as much as possible of old tape is pulled free from the up side, and the side is retaped with kraft paper tape. The carton is then turned over and old tape is again pulled free from the up side. The carton is then ready for filling. In order to automate this operation we have to find some method to automatically remove old tape from cartons, or use another method of sealing the carton to eliminate the tape cleaning operation . . .

Manufacturing Engineer

CASE 2011-P

POSITIONING TABLE

. . . We are looking for a manufacturer who can build a special work table that can be adapted to our present operation. At the present time we make cutouts of various sizes in 16, 18, and 20 gauge sheets of carbon steel flat pans. The cutouts are made by use of a Pullmax (shearing and forming) machine with a shearing head; the work is manually moved through and into the machine. We will require a positioning table to which to clamp the work. It should be capable of moving into the throat of the machine and outward a minimum of 37 inches (machine has a 48-inch throat). In addition, the positioning table would be required to move through the machine and backward a distance of 81 inches. We would be pleased to be placed in touch with a manufacturer who might make such a table . . .

Executive Vice President

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AUTOMATION

FEE

Fee for the Third Conference on Manufacturing Automation is $85 which will include the Banquet, the noon Luncheons, and a copy of the Transactions.

LODGING

Rooms are available at the Union Club on the campus at $4 and $6 single, $6 double, and $7 to $9 twin. Room reservations may be made with the Union Club by the form supplied. Accommodations are also available at the Fowler Hotel in Lafayette (city bus to campus) from $3.50. Write direct. For those driving, reservations may be made at the Morris-Bryant Motel, Cedar Crest Motel, or Green Acres Motor Court (2-4 miles north on U. S. 52). For additional information, write K. E. Glancy, Div. of Adult Education, Purdue University, Lafayette, Ind.

CONFERENCE TOPICS AND SPEAKERS

Engineering Costs—Who Pays? (Automation Panel)

BUYERS K. C. BUTTERFIELD, Staff Master Mechanic, Chrysler Corp.
W. W. KUYPER, Manager, Manufacturing Engineering, Large Steam-Turbine Generator Dept., General Electric Co.
R. L. SCHOENBERGER, Manager, Production Engineering Dept., R. R. Donnelley & Sons Co.
W. A. STADTLER, Director of Manufacturing Research, I.B.M. Corp.

SELLERS J. R. BAREFOOT, President, Federal Machine & Welder Co.
LEO GAJDA, Vice President, Snyder Corp.
E. McFERREN, Vice President-Sales, Giddings & Lewis Machine Tool Co.
W. K. STOKES, Vice President-Sales, Alvey Ferguson Co.

Manufacturing Research and Automation
T. R. BUNNELL, Manager of Manufacturing Services, Semiconductor Div., Sylvania Electric Products Inc.

Getting a Grip on Costs and Payoff
K. H. MEYER, Manager, Mfg. Services, Reliance Electric & Engineering Co.

Organizing to Reduce Costs through Automation
C. D. EVANS, Ass't. Manager, Mfg. Research, International Harvester Co.

Process Analysis and Machine Procurement
H. A. LEONE, Manager, Headquarters Mfg. Lab., Westinghouse Electric Corp.

Automating Assembly
C. H. STANDISH, President, Designers for Industry Inc.

Integrating the Packaging Operation
WILLIAM WOOD, President, Processes Research Inc.

Techniques for Parts Handling
R. H. BONNER, Application Engr., Industrial & Machine Tool Operations, Radio Corp. of America

Dispensing Problem Materials in Process
L. E. HARPER, President, Omega Machine Co. Div., B-I-F Industries Inc.

Mechanization for Distribution
E. J. HARDY, Ass't. Supt., Engineering Equipment Development, Western Electric Co.

Temperature Controls
H. G. PAYNE, Manager, Measurement Group Sales Product Div., Foxboro Co.

Using Relay Control Effectively
ZEKE SMITH, Vice President & Tech. Dir., Potter & Brumfield Div., American Machine & Foundry Co.

Doing the Job with Photoelectrics
J. J. LAREW, Product Engr., Specialty Control Dept., General Electric Co.

LUNCHEON AND BANQUET TOPICS AND SPEAKERS

Pioneering in Automation
W. C. LEONE, Vice Pres. & Gen'l. Mgr., Electronics Div., Rheem Mfg. Co.

You and the MEC
F. I. ELLIN, Chief Production Engr., Ohmite Mfg. Co.

A Look Into Tomorrow
JOSEPH HARRINGTON JR., Head, Mechanical Engineering Section, Arthur D. Little Inc.

Don't Give Up
ROBERT MOORE, President, Moore Equipment Co.

The Inevitability of Automation
H. A. STRICKLAND JR., Vice President & Gen'l. Mgr., Industrial Electronics Div., General Electric Co.

Mail to: AUTOMATION CONFERENCE, Comptroller's Office (Conferences), Purdue University.

ROOM RESERVATION

Please reserve in the Union Club the accommodations checked:

Nights: April 11 ☐ April 12 ☐ April 13 ☐

Single Bed—Bath ☐ Twin Beds—Bath ☐

If necessary, will share twin-bed with another member ☐

Room will be shared by _____

Please send confirmation:

Name _____

Company _____

Address _____

CONFERENCE REGISTRATION

The following persons plan to attend the AUTOMATION CONFERENCE, April 11, 12, and 13, 1960 (name and title, please):

Name _____

Title _____

Name _____

Title _____

$_____ is enclosed for the registrations checked at $85 each. (Make checks payable to Purdue University.)

☐ Fees will be paid at registration time.

Name _____

Company _____

Address _____

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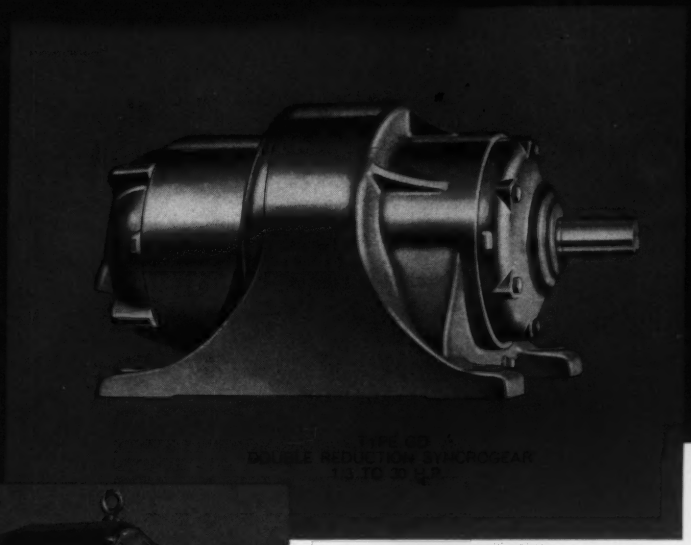
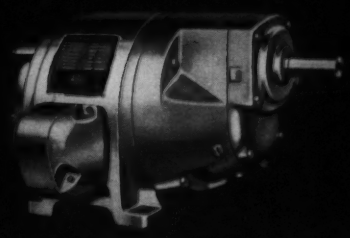


TYPE GD
DOUBLE REDUCTION SYNCROGEAR
1/3 TO 30 H.P.



TYPE GH
SINGLE REDUCTION SYNCROGEAR
1/3 TO 30 H.P.

TYPE GR
SINGLE REDUCTION SYNCROGEAR
1/6 TO 10 H.P.

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Again U.S. introduces a new first in gearmotor design: Gears *honed to super finish* for quiet, smooth running and longer life. A long succession of Syncrogear innovations by U.S. during the last 25 years have been widely adopted. **Through-hardening** of gears... the **solid-shank pinion**... the sturdy **"pyramidal" base... micro-shaving** of gears... solid cast **one-piece case**..."crowned" helical gear teeth of **elliptoidal design**... all these add years of trouble-free operation to Syncrogear life. To assure precision, U.S. makes its own gears. For more information on U.S. Syncrogear features, send for free color brochures: Syncrogear Bulletin No. F-1880, Right-Angle Worm-Gear Syncrogear Bulletin No. F-1650, or Shaftmount Syncrogear Bulletin No. F-1994.

U.S. ELECTRICAL MOTORS INC.

P.O. Box 2058 • Los Angeles 54, California, or Milford, Connecticut

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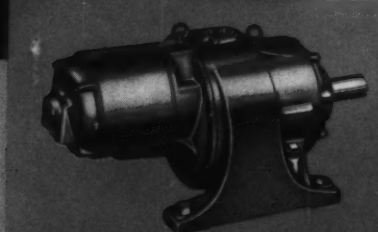
TYPE GW
RIGHT-ANGLE, WORM-GEAR
SYNCROGEAR
1/3 TO 2 H.P.

TYPE GDV
VERTICAL SYNCROGEAR
3 TO 30 H.P.



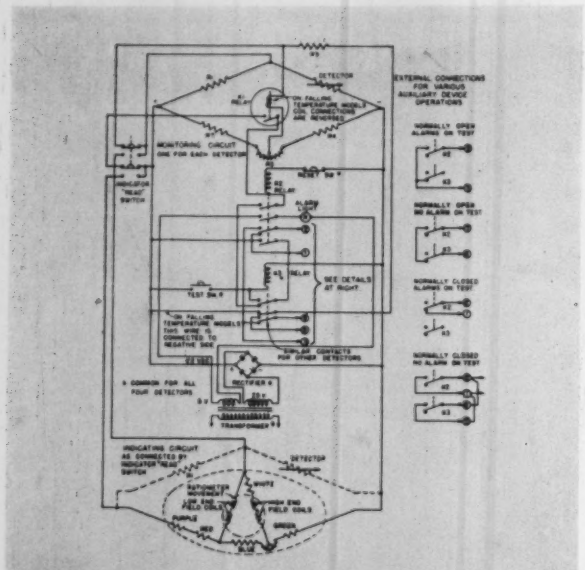
TYPE GM
TRIPLE REDUCTION SYNCROGEAR
1 TO 10 H.P.

TYPE GDF
MOTOMOUNT SYNCROGEAR
1 TO 60 H.P.

TYPE GC
SHAFTMOUNT SYNCROGEAR
1/4 TO 40 H.P.

Questions and Answers on the EDISON OMNIGUARD SYSTEM

The Most Effective Means of Measuring and Safeguarding Temperatures and Pressures



Q. How does the Omniguard System work?

A. Edison's Omniguard is characteristically simple and unique in its operation. Each Omniguard channel is a conventional D-C Wheatstone bridge circuit in which an Edison temperature or pressure detector forms the variable leg of the bridge. As the temperature or pressure rises and falls, the detector resistance increases or decreases. An Edison relay (K1) across the bridge senses the current flowing through it. When conditions are normal the current flows in the direction to hold the relay contacts open. When a variation occurs, however, current flow reverses and the contacts of this alarm relay close. Relay K1 energizes the coil of auxiliary relay K2 which actuates an alarm light on the panel face to show which detector is "off-normal," actuates an external alarm or annunciator and maintains the alarm indefinitely — until conditions have returned to normal and the normally closed reset switch is opened.

Any temperature or pressure can be read at any time by pressing the indicator read switch for that point.

Q. Is Omniguard dependable?

A. Reliability is built in. Since each measuring channel is an independent, separate circuit, complete system failure is unlikely. Only the most reliable components are used. Edison resistance temperature detectors don't "drift" over years of service. There are *no* scanning mechanisms to wear out . . . *no* delicate components . . . *no* electronic circuits . . . *no* amplifiers . . . *no* periodic maintenance requirements.

Q. Is Omniguard flexible?

A. Completely. A system can monitor as few as 4 or as many as hundreds of variables. Buy only what you need. Since channels are independent of one another, each can be set to alarm at a different temperature or pressure. Alarm settings can be changed easily and quickly.

Omniguard can be used for alarm or shut down of equipment, alarm can be local and remote, is easy to telemeter to remote control station.

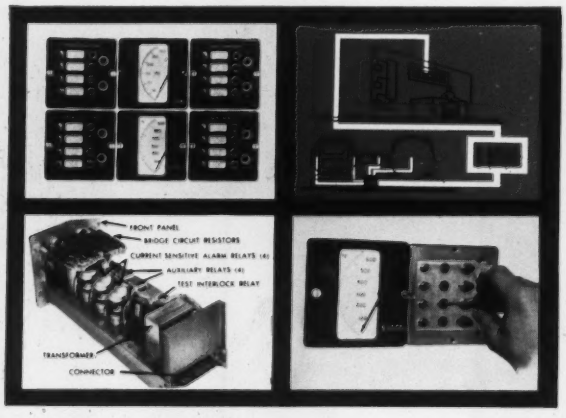
Q. Is Installation economical?

A. Omniguard is the simplest system available. Fewer parts mean lower costs, less maintenance. Plug-in monitors are installed in minutes with no special tools or calibration. Ordinary copper wire connects remote detectors to monitors. Monitor units act as their own annunciators, identify each temperature and pressure, eliminating the need for extra equipment in most installations. Omniguard is a *complete* system with all parts including hardware supplied by Edison.

Q. How accurate are Edison's Resistance Temperature Detectors?

A. In the range from −200°F to +1350°F, no other type of detector is as stable, sensitive, and accurate over years of service. Response times of 0.8 seconds are common — detectors are repeatable to .05% over years of use, resistance being directly proportional to temperature.

Resistance Pressure Detectors are accurate to 1% or better depending on pressure range.



For complete information on the Edison Omniguard System, industry's simplest, most reliable means of continuously monitoring critical temperatures and pressures, write for Bulletin 3036C.

Thomas A. Edison Industries

INSTRUMENT DIVISION

86 LAKESIDE AVENUE, WEST ORANGE, N. J.

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